The Federal Plan for Meteorological Services And Supporting Research

FISCAL YEAR 1980

FEDERAL COORDINATOR FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

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PREFACE

Section 304 of Public Law 87-843 requires that, in connection with the budget presentation for each fiscal year, the Congress will be provided with a horizontal budget showing the totality of the programs for meteorology, the specific aspects of the program and funding assigned to each agency, and the estimated goals and financial requirements. The Bureau of the Budget in its Circular A-62 of November 13, 1963, made the U.S. Department of Commerce responsible for a systematic and continuing review of basic and specialized meteorological requirements, services and supporting research. Commerce established the Office of the Federal Coordinator in NOAA to conduct this program. The plan prepared annually as directed by Circular A-62 is also intended to satisfy the requirements of Section 304 of Public Law 87-843.

The principal work of coordinating weather activities and preparing and maintaining the Federal plan is performed by two interdepartmental committees--the Interdepartmental Committee for Meteorological Services and the Interdepartmental Committee for Applied Meteorological Research. Membership is shown on the inside cover of this Plan. These committees and their subcommittees make systematic reviews of basic and specialized meteorological requirements, services, and related supporting research. They also prepare specialized plans that supplement these activities. Specialized plans that are current or under preparation are highlighted in Section III of this Plan.

Membership for two other activities under the Federal Coordinator for Meteorological Services and Supporting Research also is shown on the inside cover of this Plan--the Joint Committee for Space Environment Forecasting and the Interagency Committee for the World Weather Program. The activities of these committees are documented elsewhere and are not included in this Plan.

Richard E. Hallgren
Federal Coordinator for Meteorological
Services and Supporting Research

CONTENTS

OVERVIEW OF FEDERAL METEOROLOGICAL PROGRAMS AND RESPONSIBILITIES

The importance of weather in all facets of life and the U.S. national economy is indicated by the number and distribution of meteorological activities in the Federal Government. The Departments of Agriculture, Commerce, Defense, Energy, and Transportation, the Environmental Protection Agency, and the National Aeronautics and Space Administration provide, or fund, meteorological services or supporting meteorological research. This section gives an overview of each Federal agency's meteorological responsibilities. Section II discusses each agency's program in terms of ongoing efforts, new starts, decreased or completed efforts, and the requirements or goals to which they respond. Section III summarizes special plans, their purpose, status, and benefits. The appendices of Section IV describe each agency's activities in greater detail.

U.S. Department of Agriculture

Weather is one of the most important economic factors in agriculture. The supporting research program of the Department of Agriculture emphasizes the interaction of weather and climate with plants animals, and the environment. In the area of mountain meteorology, studies are being done concerning the interaction between mountainous terrain and the atmosphere in such problems as precipitation, temperature specification. and wind flow.

U.S. Department of Commerce

The U.S. Department of Commerce, through its National Oceanic and Atmospheric Administration (NOAA), is the principal meteorological agency of the Federal government. By law, NOAA is responsible for reporting the weather of the United States and certain other territories of interest, providing weather forecasts and warnings to the general public, developing and furnishing specialized weather services for specific user groups, and recording the climate of the United States. This weather service and research mission is carried out within NOAA by the National Weather Service (NWS), National Environmental Satellite Service (NESS), Environmental Research Laboratories (ERL), and the Environmental Data and Information Service (EDIS).

NWS carries out four broad functions that are basic to the development and dissemination of its principal product, weather reports. These are data acquisition, forecasts and warnings preparation, communications, and applied research and development for the first three functions. Public weather and warning services contribute toward improving the comfort and convenience of the public in general, reducing loss of life and property caused by natural atmospheric hazards, and promoting the national economy. Special meteorological services support the meteorological needs of agricultural, forestry, aeronautical, marine,

and other activities.

NESS provides imagery and other quantitative data, on a regular global basis, of the Earth and its environment, through operating a national operational environmental satellite system of polar-orbiting and geostationary satellites. Research and development activities within NESS are directed toward improved observing sensors and techniques and new applications for environmental satellite data.

ERL research programs related to basic meteorological services are oriented toward providing the understanding and developing the techniques and new technologies that will form the basis for future improvements in the Nation's weather services.

EDIS disseminates global meteorological and climatological data and information to meet the needs of users in commerce, industry, agriculture, the scientific and engineering community, the general public, and Federal, State, and local governments. It also provides experiment design, data management, and analysis support to national and international meteorological research programs. In addition, it assesses the impact of climatic fluctuations on yield of selected grain crops, energy demand and conservation, and other environmentally sensitive activities.

U.S. Department of Defense (DOD)

DOD operates a military environmental service system. The mission of this system is to provide tailored worldwide meteorological and oceanographic prediction services in support of military forces around the globe. This service directly supports all phases of military operations, from strategic planning to tactical operations. The U.S. Navy's Naval Oceanography Command and the U.S. Air Force's Air Weather Service are the primary military performing agencies. The Army and the Marine Corps each have a small generic weather support capability; however, they depend upon the primary weather services for support. The military weather services contribute to the national and international weather observing capability by making conventional observations on land and at sea where there is no other conventional weather observing capability and where the observations are most needed to meet military requirements. In addition, DOD maintains special observing capabilites such as the Defense Meteorological Satellite Program and aerial weather reconnaissance to meet unique military requirements. The reconnaissance program also serves national needs for data from tropical and coastal winter storms. Observational data are sent by military communications networks to military and civil facilities in the United States and overseas. Analysis, forecasting, and operational analysis functions are performed at two primary processing centers and at field weather service units that respond to needs of command units and tactical forces in the field. The military weather service not only provides statements of

past, present, and expected weather conditions, but also assesses the consequences of weather and considers military options available under the specified conditions.

U.S. Department of Energy (DOE)

DOE supports meteorological services activities at nine of the national laboratories and the Nevada test site. Meteorological services are required for laboratory operations and field experiments. The supporting research program includes studies concerning safety aspects of transport and storage of nuclear power systems used on space missions and possible radiation from nuclear tests.

U.S. Department of Transportation (DOT)

The Federal Aviation Administration (FAA) is responsible for the safety and separation of aircraft and the efficiency of flight operations. The adequacy of aviation weather information contributes significantly toward the fulfilling of these responsibilities. FAA makes recommendations to the U.S. Department of Commerce on civil aviation meteorological services, provides specialized equipment and surface observations at certain airfields, and distributes weather data over civil communications systems.

Weather information for pilots is made available through flight service stations, recorded telephone messages, scheduled broadcasts over air navigational aids, and separate continuous transcribed weather broadcasts. Thirteen Air Route Traffic Control Centers now have weather service units manned by NWS meteorologists.

FAA maintains a continuing research program to improve aviation weather service to the National Airspace System and its users. This is documented in an Aviation Weather System Preliminary Program Plan drafted in 1978 and is described in more detail in Appendix D. FAA also has a continuing engineering effort to improve existing weather equipment and to develop new instruments.

The U.S. Coast Guard is authorized to cooperate with the National Weather Service (NWS) in observing, forwarding, and disseminating weather information. Observations taken on Coast Guard units are transmitted together with meteorological reports from coastal and high seas commercial shipping to NWS forecast offices via Coast Guard communications facilities. Facilities are also provided for data-links between NWS automated units, some of which are located at Coast Guard stations and on large navigational buoys, and the data collection center. Resulting NWS weather forecasts are included in the regularly scheduled Coast Guard Marine Information Broadcasts. In addition, support for buoy placement and maintenance and other logistics matters is provided to the NOAA Data Buoy Office.

Environmental Protection Agency (EPA)

EPA is responsible for working with State and local government agencies to ensure that air quality meteorological support programs are adequate. Operational support includes review of the meteorological aspects of environmental impact statements and State implementation plans, the application of dispersion models, and the preparation of dispersion studies and evaluations. Applied research support is in the area of model development and evaluation, climatic analyses, and the atmospheric effects of pollutants.

National Aeronautics and Space Administration (NASA)

The authority for NASA activities in meteorology ensues from the DOC-NASA basic agreement (July 1973), and Circular A62 from the Bureau of the Budget, November 13, 1963.

The NASA weather and climate program consists of an integrated effort to develop new technology, hardware, applications, and theory for use in improving the quality of meteorological information to meet national needs. A central assumption to all of NASA's efforts is that by use of satellite observing systems, much of the needed data can be collected and processed in a more cost effective manner than by any other means. For convenience in management, the NASA program is divided into three components:

- Development of coordinated space and ground systems for severe storm detection, prediction, and warning.

- Development and application of space technology to improve forecasting for periods up to 2 to 3 weeks.

- Investigation of the potential for monitoring and predicting climate changes.

FINANCIAL ANALYSIS

The following tables summarize information on Federal programs for meteorological services and supporting research. Funds reported for fiscal 1980 are reflected in the President's budget and should be used for planning purposes only. In table 1 the total meteorological program being requested by Federal agencies for fiscal 1980 is $823,866,000, an increase of $55,924,000 over fiscal 1979. Significant changes in the operational program include increases of $10,334,000 for DOD and $7,166,000 for DOC and a decrease of $2,008,000 for FAA. In supporting research, NASA, DOC, and DOD plan respective increases of $23,800,000; $8,146,000; and $7,617,000.

Tables 2 and 3 show how these funds are distributed according to functional categories. Under operational costs (table 2), major decreases in DOC are shown in Observations and Dissemination, and increases in Analyses and Forecasts and General Agency Support. DOD's increases are distributed throughout the functional categories, while FAA's decreases are found in Observations and Communications. In supporting research (table 3), increased emphasis is generally evident government-wide in all categories.

Table 4 illustrates how funds for fiscal 1980 will be distributed by service. Here it can be seen that the bulk of the funds will be dedicated to basic, aviation, and military operations and supporting research.

Table 5 lists agency manpower engaged in weather operations by function.

The larger interagency fund transfers reported in table 6 for meteorological operations and supporting research in fiscal 1979 include $54,071,000 (DOC to NASA) for the meteorological satellite program; $4,346,000 (DOC to DOD) for operational weather reconnaissance; $2,600,000 (EPA to DOC) for operational and research support to various EPA offices; $2,475,000 (DOC to DOT) for radar equipment, rents, utilities, and maintenance; $1,866,000 (DOT to DOC) for Center Weather Service Units in 13 ARTCCs; $790,000 (DOT to DOC) for development work in observation systems as well as in dissemination and forecast techniques; $1,740,000 (DOE to DOC) for services in support of the Nation's nuclear testing program; $1,300,000 (NASA to DOC) for providing forecast and support services for space programs; and $862,000 (DOD to DOC) principally for climatic services.

Table 7 shows no major changes are planned in observing locations for fiscal 1980. The figures for surface (land) in the Coast Guard account for the six light house stations where automated navigational

Table 1 - Meteorological operations and supporting research, by agency
(thousands of dollars)

Agency	Operations			Supporting research			Total		
	FY79	FY80	Net difference	FY79	FY80	Net difference	FY79	FY80	Net difference
Agriculture	530	535	+ 5	2,865	3,232	+ 367	3,395	3,767	+ 372
Commerce	320,332	327,498	+ 7,166	15,862	24,008	+ 8,146	336,194	351,506	+15,312
Defense	257,086	267,420	+10,334	33,539	41,156	+ 7,617	290,625	308,576	+17,951
Energy	2,994	2,933	- 61	196	214	+ 18	3,190	3,147	- 43
Transportation									
Coast Guard	1,398	1,464	+ 66	-	-	-	1,398	1,464	+ 66
FAA	78,793	76,785	- 2,008	13,627	12,447	- 1,180	92,420	89,232	- 3,188
EPA	500	500	± 0	6,450	8,000	+ 1,550	6,950	8,500	+ 1,550
NASA	1,270	1,374	+ 104	32,500	56,300	+23,800	33,770	57,674	+23,904
Total	662,903	678,509	+15,606	105,039	145,357	+40,318	767,942	823,866	+55,924

Table 2 - Agency operational costs, by function
(thousands of dollars)

Agency	Observations		Analyses & forecasts		Communications		Dissemination to users		General agency support		Total	
	FY79	FY80	FY79	FY80	FY79	FY80	FY79	FY80	FY79	FY80	FY79	FY80
Agriculture	342	342	188	193	-	-	-	-	-	-	530	535
Commerce	111,683	107,899	86,862	98,780	10,343	10,711	53,837	48,609	57,607	61,499	320,332	327,498
Defense	125,930	124,606	30,873	33,235	17,107	20,957	35,837	37,775	47,339	50,847	257,086	267,420
Energy	1,467	1,437	-	-	30	30	210	205	1,287	1,261	2,994	2,933
Transportation												
Coast Guard	342	350	-	-	190	196	165	175	701	743	1,398	1,464
FAA	17,864	16,651	-	-	22,554	20,449	21,446	21,764	16,929	17,921	78,793	76,785
EPA	-	-	500	500	-	-	-	-	-	-	500	500
NASA	290	325	507	527	69	73	118	124	286	325	1,270	1,374
Total	257,918	251,610	118,930	133,235	50,293	52,416	111,613	108,652	124,149	132,596	662,903	678,509
% of total program	39	36	18	20	8	8	17	16	18	20		

Table 3 - Agency supporting research costs, by function
(thousands of dollars)

Agency	Observations		Description & prediction		Dissemination		Systems & support		Total	
	FY79	FY80	FY79	FY80	FY79	FY80	FY79	FY80	FY79	FY80
Agriculture	-	-	2,865	3,232	-	-	-	-	2,865	3,232
Commerce	5,330	8,048	8,552	12,160	-	-	1,980	3,800	15,862	24,008
Defense	14,632	19,189	9,731	13,058	600	905	8,576	8,004	33,539	41,156
Energy	98	107	98	107	-	-	-	-	196	214
Transportation										
Coast Guard	-	-	-	-	-	-	-	-	-	-
FAA	3,138	2,120	676	650	1,292	5,048	8,521	4,629	13,627	12,447
EPA	-	-	6,450	8,000	-	-	-	-	6,450	8,000
NASA	18,700	29,800	-	-	-	-	13,800	26,500	32,500	56,300
Total	41,898	59,264	28,372	37,207	1,892	5,953	32,877	42,933	105,039	145,357
% of total program	40	41	27	25	2	4	31	30		

Table 4 - Meteorological operations and supporting research, by service for fiscal 1980
(thousands of dollars)

Agency	Basic		Aviation		Marine		Agriculture & forestry		General military		Other		Total	
	Opns	Supp Rsch	Opns	Supp Rsch	Opns	Supp Rsch	Opns	Supp Rsch	Opns	Supp Rsch	Opns	Supp Rsch	Opns	Supp Rsch
Agriculture	-	-	-	-	-	-	535	3,232	-	-	-	-	535	3,232
Commerce	289,171	22,329	24,992	81	4,352	1,443	7,878	155	-	-	1,105	-	327,498	24,008
Defense	42,191	-	141,941	1,794	12,508	2,152	-	-	45,672	36,960	25,108	250	267,420	41,156
Energy	-	-	-	-	-	-	-	-	-	-	2,933	214	2,933	214
Transportation														
Coast Guard	918	-	-	-	546	-	-	-	-	-	-	-	1,464	-
FAA	8,157	-	68,628	12,447	-	-	-	-	-	-	-	-	76,785	12,447
EPA	-	-	-	-	-	-	-	-	-	-	500	8,000	500	8,000
NASA	-	56,300	-	-	-	-	-	-	-	-	1,374	-	1,374	56,300
Total	340,437	78,629	235,561	14,322	17,406	3,595	8,413	3,387	45,672	36,960	31,020	8,464	678,509	145,357
% of total program	50	55	35	10	2	3	1	2	7	26	5	4		

Table 5 - Agency manpower engaged in weather operations, by function

Agency	Observations		Analyses & forecasts		Communications		Dissemination to users		General agency support		Total	
	FY79	FY80	FY79	FY80	FY79	FY80	FY79	FY80	FY79	FY80	FY79	FY80
Commerce	1,409	1,391	1,804	1,824	134	134	1,013	1,004	1,344	1,344	5,704	5,697
(1)	30	30	252	252	-	-	-	-	36	36	318	318
Defense	1,760	1,763	1,048	1,047	626	618	2,089	2,091	1,394	1,369	6,917	6,888
(2)	302	302	590	590	218	218	256	256	992	996	2,358	2,362
(3)	2	2	6	8	2	2	3	3	3	3	16	18
Transportation												
Coast Guard												
(2)	36	35	-	-	20	20	18	18	23	23	97	96
FAA												
(2)	327	330	-	-	583	537	833	884	486	534	2,229	2,285
Total	3,866	3,853	3,700	3,721	1,583	1,529	4,212	4,256	4,278	4,305	17,639	17,664

Table 6 - Interagency fund transfers for meteorological operations and supporting research
(thousands of dollars)

Agency		Funds	
Transferred from	Transfered to	fiscal year 1979 Operations	Research
DOC	NASA	$54,071	-0-
DOC	DOD	4,346	-0-
EPA	DOC	-0-	2,600
DOC	DOT	2,475	-0-
DOT	DOC	1,866	790
DOE	DOC	1,740	146
NASA	DOC	1,300	-0
DOD	DOC	862	95
DOT	DOD	-0-	300
DOT	Small Bus. Admn.	-0-	
DOT	DOI	-0-	100

Table 7-Locations by observation function, fiscal years 1979 and 1980

Observation Function	Agency	No. FY79	FY80
Surface(land)	Commerce[1]	496	496
	Defense(U.S.)	155	155
	Defense(overseas)	83	83
	Energy	10	10
	Transportation(FAA)	365	370
	Transportation(Coast Guard)	145	139
	NASA	3	3
Surface(marine)	Commerce(merchant ships cooperative program)	2,000	2,000
	Transportation(Coast Guard ships)	77	77
	Defense(ships with meteorological personnel)	29	29
	NOAA ships	24	24
Upper air(rocket)	NASA	1	1
	Defense	12	12
	Energy[2]	2	2
Upper air(balloon)	Commerce(U.S.)	69	69
	Commerce(overseas)	28	28
	Defense(fixed)(U.S.)	10	10
	Defense(fixed)(overseas)	5	5
	Defense(ship)	30	30
	Defense(mobile)	37	37
	Energy[2]	2	2
	NASA(U.S.)	3	3
	Transportation/Coast Guard[3]	19	19
Weather radar	Commerce(U.S.)	117	119
	Defense(U.S.)	93	93
	Defense(overseas)	19	20
	NASA(U.S.)	1	1
Weather reconnaissance	Defense(No.of aircraft)[4]	20	20

[1]Cooperative stations operated by Departments of Agriculture, Interior, and Transportation, other public and private agencies, and those manned by volunteers are not included. Also excluded are about 300 Supplementary Aviation Weather Reporting Stations and foreign cooperative stations.

[2]Inactive, but available for use.

[3]Balloon support facilities inactive, but available for use.

[4]7WC-130s operated by AF Reserve

aids will be installed and personnel removed.

The following paragraphs discuss individual agency programs.

Department of Agriculture

The suporting research program in Agriculture will be increased $367,000 in fiscal 1980 in efforts designed to improve models useful for crop-yield forecasting in domestic and foreign areas.

U.S. Department of Commerce

To ensure that basic responsibilities are fulfilled in providing weather information and warning services to the Nation, the U.S. Department of Commerce has established the following long-range goals related to five operational functions that are common to all meteorological services:

A. Observations - To obtain surface, marine, upper air, radar, and satellite observations of the atmosphere and oceans in sufficient density, frequency, and quality to serve as the foundation for forecast, warning, and environmental quality assessment services of NOAA, foreign government agencies, and domestic users.

B. Analyses and Forecasts - To develop and improve methods of describing and predicting meteorological conditions; provide worldwide data and information on the atmospheric and marine environment; and issue timely and accurate quidance products on climate and the weather for use by NOAA, other Federal agencies, and the public. To reduce loss of life, human suffering, and economic losses through timely and accurate warnings of hurricanes and tornadoes and through improved public response to those warnings. To furnish weather information for safe efficient aircraft operations and management of the National Airspace System as recommended by the FAA; specialized agricultural weather advisory services to assist the producer in optimizing food and fiber production; specialized services to Federal, State, and local agencies in their programs for forest and range fire prevention, control and management, and for urban air pollution; climatic assessments to managers of critical national resources; and specialized oceanographic forecast and warning services to the Nation's maritime industry, the general public, and other government agencies so that marine activities may be safe, efficient, and economical.

C. Communications - To provide a communications network for collecting and distributing data for use in support of weather forecast and warning services to the Nation.

D. Dissemination to Users - To develop and implement systems to reduce response time to natural disasters, and improve dissemination of weather information.

E. General Agency Support - To maintain equipment, training, and administrative support programs necessary to meet long-range goals.

An operational program of $327,498,000 is being requested for fiscal 1980, which is a net increase of $7,166,000 from fiscal 1979. This consists of an adjustment to the base funding for fiscal 1979 of $10,140,000 to allow for unavoidable increased costs of ongoing activities; program increases of $14,401,000; reduction in Automation of Field Operations and Services (AFOS) procurement of $6,630,000; a decrease in accrued contract costs in the satellite program of $9,100,000; and an OMB-directed reduction of $1,879,000 in base programs that includes the closing of 22 Weather Service Offices.

The planned program increases for fiscal 1980 totaling $14,401,000 comprise the following specific efforts. To improve the observational program, $1,900,000 is being requested to provide automated observations from coastal and offshore platforms. The additional resources will equip 104 coastal and 25 offshore platforms with automated sensors and communication systems on the continental U.S. and Alaska coasts; the system is to be completed by fiscal 1984. Without these funds, NOAA will be unable to replace staffed U.S. Coast Guard headland stations scheduled to close when the Coast Guard automates its navigational stations and removes the voluntary weather observers who provide essential meteorological observations to NOAA. These data are used by forecasters for preparing short-term local forecasts in direct support of marine interests. In addition, $550,000 is planned to purchase and install satellite display equipment at four Weather Service Forecast Offices (WSFOs) Pittsburgh, Philadelphia, Charleston, W. Va. , and Louisville in support of the four-State flash flood warning program. This is designed to improve the capability of the WSFOs to identify, diagnose, and monitor development of potentially destructive weather phenomena. An amount of $230,000 is requested to operate and maintain a Weather Service Office and local warning radar at Jackson, Kentucky, and a local warning radar at San Juan, Puerto Rico.

Under Analyses and Forecasts a total increase of $8,600,000 is being requested. Of this amount, in response to a multi-agency initiative to support agricultural programs, $2,200,000 is being requested to plan increased use of remote sensing technology, improve models, and develop data bases to assist Federal agriculture decision makers in formulating prudent marketing policies and reducing potential losses due to weather conditions. In addition, increased agrometeorological consulting services, weather briefings, climatic summaries, and special studies will be provided at a Joint Agricultural Weather Facility in the U.S. Department of Agriculture headquarters, in response to a stated requirement by the Secretary of Agriculture. A requested $2,200,000 will be used to establish an archival and retrieval system for data from the Geostationary Operational Environmental Satellite system, and to establish and develop the data management capability required in the U.S. Climate Program and the NOAA Climate Program. An increase of $1,800,000 will provide initial funding for the upgrading, and eventual replacement, of the three IBM 360/195s at NOAA's

central computer facility in Suitland, Md. The proposed funding will extend over 5 years and will provide the basis for a 10-year cycle for evolutionary upgrading of computing power and also provide for increased computing capacity at the River Forecast Center terminals. A total of $1,100,000 is planned for a coordinated ocean services program to establish ocean service centers at six WFSOs, support an NMC development group to provide new and improved guidance materials, and provide oil spill forecasting capabilities, i.e., wind speed and direction, currents, and weather. An increase of $700,000 is being requested to provide the meteorologists, equipment, and communications needed to establish and develop an operational satellite function capable of providing routine oceanic support through satellite products and consultation. An increase of $400,000 will provide a nucleus of NOAA people, and professionals temporarily acquired under the Intergovernmental Personnel Act, to establish and staff the National Climate Program Office. The program is responsive to the National Climate Act of 1978 that establishes a National Climate Program. It also will provide the basis for U.S. participation in a comprehensive international climate program initiated by the World Meteorological Organization in cooperation with other organizations concerned with climate-related problems.

To improve the dissemination of weather information, $600,000 is planned to procure and install 100 NOAA Weather Radio (NWR) gap-filler transmitters in support of the national flash flood warning program. With this addition, forecasts and warnings will be available to many potential listeners who are unable to receive the broadcasts from the primary transmitters. Also, $221,000 will be used for the annualized cost of providing staffing through state employees for the NWR network.

Under General Agency Support, an equipment replacement program for the NWS is planned that will require an increase of $2,300,000. The current backlog of outdated, unreliable equipment will be systematically reduced to keep pace with continuing equipment deterioration and obsolescence. The program will support all NWS instruments and electronic equipment having a unit cost under $35,000. Excluded are radar, upper air sounding systems, NWR, and AFOS.

The supporting research program for fiscal 1980 is $24,008,000 representing a $8,146,000 increase from fiscal 1979. Major items include the following: NOAA is developing a long-range program ($5 million) to optimize new and existing remote sensing technology for an improved regional-scale observing, forecast and dissemination system during the 1980s. The program focuses on identifying and meeting user needs for detailed, short-term local weather services; $980,000 is being requested for development of a storm surge model and for ocean services research and development to determine and refine methods needed to extract oceanic information from satellite data; $900,000 is planned for a new initiative called Hurricane STRIKE to expand efforts in hurricane modeling and diagnostic analysis of hurricane data to improve hurricane short-term

prediction and warning, especially hurricane landfall.

U.S. Department of Defense

To support military forces of the United States around the globe, the U.S. Department of Defense is planning a meteorological program of $267,420,000 for fiscal 1980, an increase of $10,334,000 over fiscal 1979. The Navy and Air Force are requesting respective increases of $5.5 million and $5.4 million; the Army is planning a decrease in its program of $0.6 million.

A newly established organization under the Commander, Naval Oceanography Command combines the functions of the former Director, Naval Oceanography and Meteorology and certain functions of the Oceanographer of the Navy. This command includes the former Naval Weather Service activities, the Naval Oceanographic Office, and other elements of the naval oceanographic program. The bulk of the Navy increase will be distributed among the functions of Observations, Analyses and Forecasts, and Communications. For the observational program a $3.2 million increase is planned to procure equipment for ground and upper-air observations, and shipboard readout of DMSP satellite data. To improve analyses and forecasting services, $1.2 million will be requested to upgrade the primary computer system at the Fleet Numerical Weather Central. With the expanded use of the Naval Environmental Display Station (NEDS) planned throughout the Naval Oceanography Command, an increase of $0.9 million will be applied toward related communication costs.

In the Air Force the more significant changes include an increase of $3.8 million for personnel and salary costs; $2.8 million due to increased lease and procurement costs for communication circuits and equipment; $0.7 million for technical training costs; and $0.7 million in Analyses and Forecasts for computer lease costs. It also has an offsetting decrease of $3 million in the meteorological satellite program for observations.

The Army reduction is the result of purchasing fewer calculators for rawinsonde units.

DOD's supporting research program of $40 million for fiscal 1980 comprises $21 million for the Army, $10.5 million for the Navy, and $8.4 million for the Air Force. Army research emphasis is being placed on atmospheric transmission problems associated with electro-optics and high-energy laser weapons, on artillery and rocket ballistic problems, and on making up-to-the-minute atmospheric information available at the corps or mesoscale level. The bulk of the Army's $3.6 million increase for fiscal 1980 is planned in observations for engineering development and production of an automatic atmospheric sounding set for use at the corps or mesoscale level. In the Navy, emphasis is on increasing the

capabilities for processing satellite data (i.e., sounders, microwave, infrared sensors) into geophysical data; to develop a joint Navy/Air Force microwave imager for DMSP; to continue development of numerical atmospheric and oceanographic prediction capabilities; and to develop the unique automated systems for shipboard environmental measurements and tactical environmental predictions. The Air Force's research efforts are concentrating on automated direct and remote sensing systems, weather satellite imagery analysis and application, short-range terminal forecasting and numerical prediction techniques, climatological studies, and cloud and precipitation physics.

U.S. Department of Energy

No major changes are planned in the program for fiscal 1980.

U.S. Department of Transportation

U.S. Coast Guard - At six Coast Guard light stations personnel will be removed in fiscal 1980 and replaced with automated navigational aids resulting in a decrease in program costs of $14,000. The net increase of $66,000 shown in table 1 reflects this and inflationary costs of operations.

Although this year's entries differ significantly from last year's submission, this is not due to major program changes, but to improved algorithms used in accounting for costs. One change is that observation costs do not include the cost of the facility involved, but only the cost of the person's time used. These facilities are not dedicated to meteorological observations, but process them as an added responsibility to their original missions. Additionally, costs for support to the NOAA Data Buoy Office and the NWS automated sensor program are included this year.

Federal Aviation Administration (FAA) - The major reductions in FAA's operational program for fiscal 1980 are shown in table 2 under the functions of Observations and Communications. In Observations an increase of $0.9 million for weather radar displays to provide local-use radar data to airfields is offset by a decrease of $1.2 million due to completion of a program to provide wind shear data to pilots and a $0.9 million decrease for the VORTEX display system because of changing operational requirements and costs. The VORTEX system shows comparative wind information to traffic controllers in connection with runway headings.

In Communications the decrease is principally due to reductions in teletypewriter relocation projects and reduced equipment requirements. Although the net increase for Dissemination to Users is small, it includes an increase of $1.2 million for anticipated growth in pilot

briefings offset by a decrease of $0.9 million due to reduced installation of transcriber equipment to broadcast weather information.

FAA's supporting research program for fiscal 1980 shows a net decrease of $1,180,000 over fiscal 1979 (table 3). Under Observations, the decrease is the result of equipment procurement that will be completed in fiscal 1979 to be a part of experiments using air traffic control radars for hazardous weather detection. The $3.7 million increase under Dissemination is a direct result of proposals in the Aviation Weather System Program Plan. The bulk of the decrease in Systems and Support is the result of phased procurement in the Flight Service Station Automation Program.

Environmental Protection Agency (EPA)

EPA is planning an increase of $1,550,000 for a major field program to study the effects of complex terrain on the atmospheric dispersion of air pollutants.

National Aeronautics and Space Administration (NASA)

In space operations, NASA relies on DOC through reimbursable agreements for providing forecasting and support services for space programs at the Kennedy, Marshall, Johnson, and Wallops Flight Centers. No major changes are planned in the program for fiscal 1980.

In supporting research, NASA's major increases for fiscal 1980 include the following: $16,000,000 will be applied to the Earth Radiation Budget Satellite System for spacecraft fabrication, instrumentation and system development; $4,300,000 for climate observations and climate processes; $1,300,000 is planned to develop future operational instrumentation; and $1,000,000 for increased support to the Global Atmospheric Research Program. The remaining amount of the total increase for fiscal 1980 includes small program changes distributed over a large number of projects.

SPECIALIZED PLANS

A. Federal Plan for Weather Radars - Published in November 1973, this plan describes the use of national weather radar resources in providing warnings and forecasts of severe weather for all populations within the United States. It is being revised to update current programs and identify deficiencies, to plan for research and development, and to implement new systems. Significant input to the revised plan will come from a cooperative program under which NOAA, U.S. Department of Defense, and U.S. Department of Transportation are trying to improve severe storm detection and warning for both the general public and aviation. Mesocyclone signatures foreshadowing tornado development and tornado vortex identification by Doppler radar are being evaluated for operational use. Also, the incorporation of Doppler radar capability and computer-processed color-coded displays into a new generation of radars is being evaluated as a possible replacement for the present system.

B. Federal Plans for Cooperative Backup Among Operational Processing Centers - The plans included in this document describe and update long-standing cooperative arrangements involving the civil and military meteorological services. They specifically identify emergency backup procedures to be followed by the U.S. Department of Defense's Air Force Global Weather Central and Fleet Numerical Weather Central for high-priority user products prepared by the U.S. Department of Commerce's National Meteorological Center and National Severe Storms Forecast Center in the event of extended power or computer outages at the national Centers. The users who depend directly on these products in addition to the nationwide network of Weather Forecast Offices and Weather Service Offices, include more than 200 offices of other Federal agencies and private meteorologists, whose collective services satisfy the Nation's demands for weather services and warnings.

C. Federal Plan for a National Agricultural Weather Service - This plan focuses on the need for providing specialized weather services to farmers, ranchers, and supporting agribusiness interests. It is undergoing major revision and is directed toward improving and expanding agricultural weather services during the early 1980s. It makes maximum use of the observational networks and the existing data processing and disseminating facilities of the U.S. Departments of Agriculture and Commerce.

D. National Plan for Fire Meteorological Services - This plan focuses on the need for providing specialized fire weather services to forestry and range management interests. It is undergoing major revision and will identify unmet needs in fire weather services and present plans to meet these needs. The U.S. Departments of Agriculture, Defense, Commerce, and Interior are collaborating to write the plan, with input from State and

private forestry interests.

E. National Hurricane Operations Plan - Hurricane warning service is an interdepartmental effort to provide the Nation and designated international recipients with environmental data, forecasts, and assessments concerning tropical and subtropical weather systems. This plan, updated annually, presents procedures as agreed upon by the U.S. Departments of Commerce, Defense, and Transportation for providing Atlantic and Pacific hurricane warning services.

F. National Severe Local Storms Operations Plan - This plan describes the responsibilities, roles, and procedures followed by the U.S. Departments of Commerce and Defense, and the Federal Aviation Administration in observing, forecasting, and communicating information on severe local storms over the the United States. The plan is updated annually.

G. National Winter Storms Operations Plan - This plan identifies agency responsibilities in acquiring weather information for use in predicting and providing adequate and timely warnings of severe and crippling winter storms along the east and Gulf coasts of the United States. It covers that part of the year (November 1 to April 15) having a relatively high incidence of winter storms. The agencies involved are the U.S. Departments of Commerce, Defense, and Transportation. The plan is updated annually.

APPENDIX A. - U.S. Department of Agriculture (USDA)

The supporting research program of USDA will emphasize the relationships of weather and climate to plants, animals, and the environment. Specific studies are being made on how climate affects various insect species, including development and behavior, and how to make better use of beneficial insects. Research is seeking to determine the relation between climate and such factors as crop hardiness, quality, productiveness, and drought resistance. Methods are being developed for the establishment of windbreaks and for the determination of their effect on air, soil, water, and snow movement. USDA is directing a national research program on plant disease epidemiology and forecasting in which extensive use is made of micrometeorological data observed at plant level. A pilot program is being developed to monitor moisture levels in representative soils under alternative crop and management systems, to predict soil behavior (yield, erodibility, and other behavioral aspects) under varying conditions of climate, land use, and weather.

Studies are being performed to determine the action of air pollutants on plants and methods of controlling the damage. USDA is cooperating with State and Federal agencies and universities to establish a nationwide program for monitoring deposits of atmospheric pollutants to determine their extent and effects on agriculture and natural ecosystems.

Investigations will determine the potential economic effects of weather on crop production, both domestic and foreign. One aspect of these studies is the development of models relating various weather parameters to crop yields. A worldwide meteorological data base is being compiled, and research is in progress to determine crop-yield patterns associated with various meteorological factors.

USDA has begun a national research program to determine crop response to climatic factors. Specifically, better measures will be obtained for predicting the response of wheat, grain sorghum, soybeans, and cotton to soil moisture, solar radiation, ambient and soil temperature, and precipitation. Of particular interest is the crop response at different phenological stages.

In mountain meteorology, USDA is studying the interaction between mountainous terrain and the atmosphere in such problems as precipitation, temperature specification and wind flow. A significant part of this research will be the definition of mesoscale variation. NWS and the Southeast Forest and Range Experiment Station of the Forest Service have a joint experiment to develop, test, and demonstrate a new format for fire weather service in the South. Research is being done on wind regimes characteristic of mountain terrain, with special emphasis given to modeling Santa Ana and terrain-induced flows. Flow patterns responsible for the transport and dispersion of smoke plumes from forest fires are also modeled.

APPENDIX B - Department of Commerce/National Oceanic and Atmospheric Administration

NATIONAL WEATHER SERVICE (NWS)

INTRODUCTION

This appendix describes NWS's purposes, mission, and major products and services, together with the system used to develop these products and services and to make them available to users. It shows NWS's major functions, the sequence in which they are performed, and the principal performing organizations within NWS. It also shows the resources NWS devotes to these functions and the ways in which it measures their principal outputs.

MISSION - NWS's basic purposes are:

- To help ensure the safety and welfare of the general public with respect to weather conditions, including conditions involving natural disasters.
- To further the conduct of municipal, commercial, industrial, and other activities which are affected by the weather, such as agriculture, aviation, transportation, construction, and energy transfer.

To fulfill these purposes, NWS:

- Observes and reports the weather, river and ocean conditions of the United States and its possessions.
- Issues forecasts and warnings of weather, flood, and ocean conditions.
- Develops national meteorological, hydrologic, and oceanic service systems.
- Performs applied meteorological research
- Develops community preparedness programs for weather related natural disasters.
- Participates in international meteorological activities, including exchange of data and forecasts.

BASIC ENABLING LEGISLATION AND AUTHORITY

- Organic Act of 1890 created the U.S. Weather Bureau.

- Enabling Act of 1919 allowed U.S. Weather Bureau to enter into cooperative agreements for providing agriculture weather services.

- Federal Aviation Act of 1958 outlined duties of the Secretary of Commerce for provision of weather observations and services to aviation.

- OMB Circular A-62 established criteria for Federal provision of meteorological services and supporting research.

PRODUCTS AND SERVICES

NWS produces two general kinds of products and services:

- Weather observations, forecasts and warnings, both scheduled and unscheduled, and consisting primarily of descriptions of current weather conditions and predictions of future weather events and conditions.

- Technical advisory, and other ancillary meteorologial services.

Weather Observations, Forecasts, and Warnings include:

- General weather conditions, including sky condition, temperature, wind, precipitation, visibility, pressure tides, and currents.

- Severe weather events such as hurricanes, other tropical storms, tornadoes, and thunderstorms.

- Hydrologic conditions, including river levels, flood levels, and flash floods.

- Marine weather, including coastal tides and currents, hazards to navigation on the high seas, conditions for pleasure boating, and lake ice and other factors affecting inland marine navigation.

- Tsunamis affecting the west coast of the United States, including Alaska, Hawaii, and United States territories in the Pacific.

- Aviation weather, including terminal and enroute weather advisories principally detailing type of precipitation, cloud ceilings and visibility, wind factors, and such significant enroute aviation hazards as aircraft icing, turbulence, and thunderstorms.

- o Agricultural weather, including soil moisture and temperature, leaf wetness, evaporation, drying conditions, and other factors affecting farming and ranching.

- o Environmental quality, including air pollution levels and conditions affecting wildfire control and other aspects of forest and range management.

- o Weather conditions affecting such special activities as space flight operations, atomic testing, controlled burning to remove forestry wastes, and oil spills and other emergencies affected by the weather.

Dissemination of NWS's weather reports is accomplished principally through electronic means: radio, TV, telephone, teletypewriter circuits, and facsimile. However, some is through face-to-face contact or visual inspection of products by the using community. Four principal kinds of systems are used:

- o Systems involving the mass media: radio, television, and the newspaper.

- o Those involving other government agencies, primarily the Federal Aviation Administration (FAA) but also other Federal, State, and local agencies.

- o Those involving heavy-duty answering devices operated by telephone companies.

- o The NOAA Weather Radio (NWR) System which provides continuous, direct access to the using community.

NWS is now emphasizing the NWR System. In 1979, 341 stations will be on the air nationwide.

NWS also performs a variety of other services, including:

- o Disaster preparedness services
- o Technical services for agriculture
- o Voluntary Assistance Program
- o International meteorological advice and consultations
- o Climatological services
- o Litigation and expert testimony activities

BASIC FUNCTIONS

NWS carries out four broad functions that are basic to the development and dissemination of its principal product group, weather reports. These are:

- o Data acquisition
- o Forecast and warning preparation
- o Communications
- o Applied research and development relating to the above.

Data acquisition involves observation, collection, and some preprocessing of data on atmospheric, hydrologic, and oceanic conditions. Atmospheric data are by far the most important, accounting for more than 90 percent of the data acquisition budget and are further subdivided by type of observation:

- o Surface
- o Upper air
- o Radar
- o Satellite

Forecast preparation includes data processing and analysis, as well as development of predictive material. The function is subdivided by the scale and focus of this material.

- o Large-scale forecasting focuses on national and hemispheric weather and mostly produces guidance material for other forecasting.

- o Specialized forecasting focuses on areas determined by the nature of the specific conditions and the events being predicted and produces both guidance material and products intended for the user.

- o Medium scale forecasting focuses on weather in State and multi-State areas, as well as zones within a State. It is the scale at which most products are issued to users.

- o Small-scale forecasting involves adaptations of medium-scale products to individual localities and communities.

The communications function divides into two subfunctions:

- o Internal communications involve the transfer and distribution of information within the meteorological community (i.e.

communications between data acquisition points and forecast preparation centers and between preparation centers). This community includes NWS, other Federal agencies (such as FAA, Coast Guard, and the Department of Defense), the international meteorological organizations, and the private practitioners.

- External communications involve transmission of weather information to the public and specialized users. It involves the sytems described in the preceding section: the media, FAA and other government agencies, commercial telephone systems, and the NWS direct broadcast system.

The functions above are carried out by the following principal organizational components:

- The National Meteorological Center (NMC) in Camp Springs, Md., makes large-scale forecasts and develops associated guidance material.

- The National Hurricane Center (NHC) in Miami, Fla., and the National Severe Storms Forecasting Center (NSSFC) in Kansas City, Mo., are concerned with specialized forecasts and associated guidance for their respective types of meteorological phenomena. The NHC is supported by five offices with regional assignments, one each in San Francisco, Honolulu, San Juan, P.R., Washington, D.C., and Boston.

- There are 13 River Forecast Centers (RFCs) that produce specialized river and flood level forecasts and guidance material. Each RFC covers a major national watershed or portion thereof.

- The 52 Weather Service Forecast Offices (WSFOs) prepare and issue medium - and small-scale forecasts and weather warnings and also acquire meteorological data. There is essentially one WSFO per State.

- The 190 local Weather Service Offices (WSOs) issue small-scale forecasts and weather warnings and acquire meteorological data.

- There are 19 Weather Service Meteorological Offices (WMSOs) and some 600 automated observing stations that also acquire data.

The functions described above are performed in a sequence which,

though occasionally modified, establishes the essentials of NWS's product flow. This sequence basically involves:

- o Data acquisition
- o Use of selected data to prepare large-scale forecasts.
- o Use of selected data and large-scale forecasts to prepare specialized and medium-scale forecasts.
- o Release of these forecasts to the user, either with or without further adaptation to reflect small-scale conditions.

Data Acquisition. The product sequence begins with the acquisition of data on atmospheric, hydrological, and oceanographic conditions for the United States and large portions of the rest of the world. Most of the data are collected by NWS, FAA, NESS, and cooperative observers (the latter including both land and shipborne observers). Some of the data also come from the weather services of other nations.

There are more than 1,000 principal surface observation points nationwide, with about 400 sites providing 24-hour service. Schedules at other sites are predicated on established needs, e.g., flight schedules. Most NWS observations are manually acquired by the WFSOs, WSOs, and WSMOs, though NWS is in the process of automating selected sites through its automated meteorological observing system. Elements observed include cloud cover, temperature, dew point, wind speed and direction, atmospheric pressure, and precipitation type and amount. These principal sites are augmented by 13,000 land-based cooperative observers, who report daily temperature variation and precipitation amounts.

Many of these field stations also send balloon-borne meteorological instruments aloft to measure temperature, moisture, pressure, and wind to 33 km above the surface. A few rocket soundings reach 100 km. There are 140 observation sites within the United States and its territories, the Caribbean, Mexico, and Central and South America. Most sites take two upper air soundings per day at the standard analysis times of 1200 GMT and 0000 GMT. These soundings are augmented by weather observations from aircraft in flight.

Specifically designed NWS weather radars monitor the location, extent, intensity, and movement of such severe or hazardous weather conditions as hurricanes, tornadoes, severe thunderstorms, and heavy snowstorms. Weather radars also are capable of qualitative estimates of rainfall amount over specific watersheds, which aid the forecasting of river floods and flash floods. About 115 weather radars are operated by WSFOs, WSOs, and WSMOs. These are augmented by about 90 weather radars operated by Department of Defense. Of the NWS radars, 56 are staffed and

operated continuously.

NESS operates weather satellite systems which "see" cloud cover through visual and infrared photography. The Geostationary Operational Environmental Satellite (GOES) system is 36,000 km above the earth's surface. Its orbit is Earth-synchronous, i.e., always stationary over the same point on the Equator. The polar-orbiting NOAA satellites orbit the Earth from pole to pole. In both systems, the resolution or accuracy of locating clouds is very high, and these systems can also be used to infer cloud thickness, temperature distribution, and vertical distribution of wind.

Hydrologic data are collected at about 8,000 river points nationwide, data measurements are made of river levels and precipitation amounts as input to prediction models that forecast river stages for 2,500 points. Some of these data are obtained automatically through NWS's Automated Hydrologic Observing System (AHOS).

Oceanographic data include "profiles" of deep ocean temperature and salinity, which are derived from bathythermographic measurements made by U.S. Department of Defense and U.S. research vessels, These are undersea measurements made at different depths. Sea-surface temperatures are observed and reported by National Ocean Survey (NOS) data buoys, the U.S. Navy, and American research vessels, as well as by ships-of-opportunity of many nations. Observations of tides, sea, and swell are also observed and reported daily.

Forecast Preparation. Once acquired, the data are transmitted to all NWS organizations that have pertinent forecasting responsibilities. The organizations then process and analyze the data and use the results to prepare their respective outputs. Such organizations include the WSFOs, and WSOs, as well as the large-scale and specialized weather forecasting organizations that have major responsibilities for preparing guidance material for the WSFOs and (through the WFSOs) for the WSOs.

Preeminent among these organizations is the National Meteorological Center (NMC), which in many respects is key to NWS's analysis and forecast function. NMC has responsibility for developing coordinated large-scale forecasts and associated guidance material for the United States and much of the rest of the Northern Hemisphere, plus portions of the Southern Hemisphere. It produces a large number and variety of graphic products describing both current and forecast conditions throughout these areas.

Current condition depictions include 3-hourly and 6-hourly pressure analyses at the surface and 12-hourly analysis at about 1.6, 5.9, and 9.8 km above the surface. Other current depictions include analyses of cloud cover, convective activity (thunderstorms and related phenomena), air stagnation potential, distribution of nationwide temperature and

precipitation, and such atmospheric dynamics as instability, vertical motion, and freezing level variations. These products are produced by a mix of computerized numerical methods and human intervention to adjust for subjective considerations. They give forecasters throughout the Nation a generalized, three-dimensional appreciation of the current weather situation.

Using information on current conditions as a starting point, NMC then uses automated numerical means (based principally on simplified models of atmospheric dynamics) to predict future conditions of the Nation's weather for periods up to 10 days.

NMC transmits this entire body of information to forecasters throughout the Nation as guidance material for the preparation of specialized, medium-scale, and small-scale forecasts which become the final products issued to the using community. This information is distributed widely. NMC makes 1,600 facsimile and teletypewriter transmissions daily to field forecasters. In addition, there are daily communications schedules for overseas users.

NMC's products are intended primarily to guide organizations responsible for specialized and medium-scale forecasts, and virtually all are made available to the public through these forecasts. A few products, however, are disseminated without change, either directly by NMC or through other NWS organizations.

Specialized forecasting covers a less than national area, either a variable area determined by the current and future condition of hurricanes, tornado systems, or other specific phenomena; or a fixed area determined by river and stream drainage. Forecasts of NSSFC and NHC fall into the first category, those of the RFCs into the second. All three, however, share two common characteristics:

- They forecast only specific meteorological or hydrological phenomena.
- Their products represent important guidance to the WFSOs and influence WSFO forecasts, but they typically also go to the user without change.

NSSFC prepares and issues tornado and severe thunderstorm "watches," which are then disseminated to the public in the threatened areas. A watch is a public-oriented statement which indicates that meteorological conditions are favorable for the development of severe thunderstorms or tornadoes. The watch statement may include advice as to what precautions should be taken by the public to protect itself from these hazards. As opposed to a watch, a warning of severe thunderstorms

or tornadoes can be issued by any NWS field facility once that facility receives any type of intelligence that a severe thunderstorm or tornado has been sighted.

NHC issues bulletins describing the current and future location, intensity, and movement of hurricanes, other tropical storms, and associated coastal tides. These bulletins are considered final products and are issued either directly or through the WSFOs to the public and other interested groups without modification.

Just as NHC and NSSFC analyze and forecast hurricanes and other severe disturbances, the 12 RFCs develop specialized analyses and forecasts of river levels and flood stages to be expected in major national watersheds. They also develop runoff and snowmelt forecasts. RFC forecasts are disseminated to the public through the WSFOs without change.

Building primarily upon the material provided by NMC, the 52 WSFOs reanalyze and develop a large number of forecast products particularized and stylized in terms of area peculiarities and special user needs. These medium-scale forecasts often are issued directly to the public without further modification. A representative list of these products would include:

- State forecasts cover general weather conditions out to 5 days for a State or, for areas like New England where the States are small, a grouping of States. Information would include expected amount of sunshine or cloudiness, precipitation, diurnal temperature variations, and wind conditions.

- Zone forecasts are similar in content to state forecasts but further particularized to an area generally comprising several counties and covering between 12,900 and 38,800 km^2.

- Recreational forecasts are similar to State forecasts, but limited to recreational zones, beaches and pleasure boating areas, skiing areas, and so on.

- Agricultural forecasts reflect a further particularization of the weather elements included in a State forecast to allow decision making by farmers in terms of spraying crops, irrigating, harvesting, and so on.

- Aviation forecasts again represent a further particularization of weather elements so that the information applies to aerodrome conditions and inflight weather.

- Marine forecasts are similar in content to State forecasts

except that they focus on coastal and high-seas weather.

- Fire weather and air pollution forecasts particularize weather elements to express either the atmosphere's ability to dilute and disperse pollutants of the effect of weather elements on wildfires.

Small-scale forecasting involves the modification of medium-scale products so that they describe a specific locality, such as a city and its suburbs, an airport terminal, a national forest, a farming community, a local recreational area, a point-source polluting area, and space launch and recovery areas. This process considers two different sets of variables: (1) topographic and climatological peculiarities, in the case of local public weather-type forecasts, and (2) unique parameterization of the basic weather elements to make them useful for specialized activities. Examples of the latter would be spraying information for crop protection or estimates of fuel-moisture content of the debris covering a national forest.

An aspect which tends to make these forecasts unique is that, unlike those described previously, they need not be made by professional meteorologists. Professional meteorologists at the WSFOs do, indeed, make small-scale forecasts, but they are also made by subprofessionals at the WSOs. For this reason, they are frequently described as forecast adaptations. They are not original products, but rather a repackaging of these products to meet localized needs. Many areas without a WSO or locally situated WSFO do not have access to such adaptations and use the applicable medium-scale forecasts instead.

Communications. Transmission of data from points of observation to forecasting centers, between such centers and within the meteorological community generally is the job of NWS's internal communication systems. These systems involve landline telephone, radio, radiotelephone, and microwave transmission. They make use of teletypewriters, facsimile equipment, telephones, and specialized computers and traffic management devices. The computers are used to perform various preprocessing operations that facilitate transmission, particularly transmission of data to forecasting centers.

Besides its own system, NWS has access to and uses a number of communication systems maintained by FAA and other government agencies. The FAA systems play a particularly important role, forming an integral part of the overall network.

NWS uses three principal groups of internal communications systems:

- Longline teletypewriter systems that are controlled by FAA and

which handle much of NWS's observation data and many of its public forecasts.

- o NWS-controlled facsimile systems that are used for the transmission of forecast guidance material, as well as some data.

- o A special NWS system reserved largely for radar data and hurricane, tornado, and other storm warnings.

External communications -- the transmission of forecast information to users -- are characterized by systems which involve:

- o Government-owned teletypewriters to commercial TV and radio stations, e.g., NOAA's Weather Wire Service.

- o Direct radio broadcasts to public through NWR.

- o Heavy-duty automatic telephone answering devices which are operated by the telephone companies and which directly give the public weather information furnished by NWS stations.

- o Direct NWS-to-the-public telephones, including automatic answering devices at NWS field offices and personalized services.

- o Government and other intermediaries, e.g., Coast Guard radio telephone, FAA weather information disseminating systems, civil defense systems such as the National Warning System (NAWAS) and systems run by private communication industries such as RCA.

- o Internal systems.

External communications is the principal effort to disseminate weather intelligence to the users -- the public, industry, and other specialized groups. The success or failure of this effort depends almost totally on the cooperation among NWS, other Government agencies, and private industry, especially the mass news media. NWS is capable of transmitting this information in a timely manner to the media, but depends heavily on the media for the further transmission to the user. For this reason, NWS's current efforts are focused on the direct radio broadcasts described earlier. Examination of direct dissemination via public-service and cable television is also underway.

NWS views the present system for collecting, preparing, and distributing weather information as too slow and cumbersome to permit optimum response to warning situations. It has been acceptable up to now, because the current system was limited by the state-of the-art in communications technology. Now, the microprocessor has been adequately developed and NWS is proceeding to a new level of communication under AFOS (Automation of Field Operations and Services), which will shorten the time between the recognition of hazardous weather and the issuance of warnings to the general public from between 5 and 15 minutes to as short a time as a minute or two in most instances.

Through AFOS, weather offices will be provided with off-the-shelf processing display and communication technology that will allow them to:

- Automate the routine duties of professional personnel.
- Provide automated assistance to the professional aspect of the forecasters' jobs.

- Communicate data to the forecaster and information to the public over high-speed computer-controlled circuits.

When fully implemented, AFOS will either replace or require large modifications in present communication systems.

Research and Development

To ensure that the quality of NWS forecasts and services continues to improve and is in line with current state-of-the-art, applied research and development is carried out in a number of areas:

- Numerical Prediction - Research and development is aimed at improving the day-to-day general forecasts and warnings and hurricane warning service by placing the analysis and prediction system on a stronger scientific basis. Numerical prediction models that simulate atmospheric and hydrologic processes are constantly worked on and better computer techniques to solve the underlying equations are developed. Long-range prediction research is aimed at developing improved forecast methods through systematic application of physical techniques, climatology and statistical analysis.

- Equipment Development - NWS conducts research to devise and develop new and improved techniques for measuring weather elements. Meteorological instrumentation is being developed with

a primary emphasis on automating the detection and dissemination of the data. Integration of automatic sensing equipment with AFOS will allow for computer controlled collection and processing of observational data. Test and evaluation of weather equipment is conducted in Sterling, Virginia. This facility, which has the capability to simulate a typical weather station, conducts tests of equipment and procedures under a wide range of environmental and operational conditions.

- o Specific Products - NWS also conducts ad hoc research and development to improve quality and timeliness of forecasts and warnings issued to the public. Research and development is conducted in the Systems Development Office, the Regional offices, the National Hurricane Center, the National Severe Storms Forecast Center, and many WSFOs to improve the forecasts of hurricane, severe local storms, general weather, flash floods and aviation weather conditions, using both dynamical and statistical techniques.

OTHER FUNCTIONS

Besides its three basic functions, NWS also carries out a number of other functions which are either:

- o Required to provide technical assistance and other services.
- o Essentially supportive in nature.

This section identifies these functions and indicates the NWS organizational components that are mainly responsible for carrying them out.

Technical Assistance Functions. Besides developing and issuing weather reports, NWS provides a number of other services that essentially involve technical assistance advice and consultation.

- o Disaster preparedness functions involve assistance to local communities in developing more effective disaster plans, training materials, and dissemination arrangements. They are carried out by specifically trained disaster meteorologists at 18 WSFOs primarily in the Midwest and South. A Washington-based Disaster Preparedness Staff coordinates this work.

- Technical assistance to agriculture involves four Environmental Studies Service Centers (ESSCs) in Texas, Mississippi, Alabama and Indiana. These ESSCs provide technical services both directly and through their respective land grant colleges.

  The WSFOs and WSOs also provide direct technical assistance.

- The Voluntary Assistance Program provides meteorological assistance to less developed countries.

- International meteorological advice and consultation is available upon request.

- NWS offices are involved in weather-related litigation activities and expert testimony.

- Climatological services are offered by the WSFOs, the WSOs, the RFCs and the ESSCs. NOAA's Environmental Data Information Service (EDIS) is also heavily involved, having the principal Federal responsibility in this area.

Support Functions. To operate and maintain NWS' various activities, substantial support functions are required. In common with other organizations, NWS requires a cadre of management and administrative personnel, but there is also more specialized support in a number of scientific and technical areas.

- Administration and management involves primarily national headquarters and NWS's six regional offices. Policy and procedural management is provided principally through the Weather Service Operations Manual.

- Engineering support involves facilities and equipment procurement, installation, and management. Equipment maintenance and repair is a major item, involving some 400 electronic technicians deployed throughout NWS' field structure and more than 10 percent of the agency's total budget.

- Research and development includes efforts to improve forecast techniques, equipment systems, and numerical weather prediction models, as well as equipment development and testing.

- o Meteorological training is carried out by the NWS Technical Training Center in Kansas City, as well as under contract through universities and other Federal agencies.

NWS also draws upon support services provided by other Department and NOAA components, particularly the Environmental Research Laboratories and the National Ocean Survey. These organizations provide research and map production services, respectively.

PERFORMANCE LEVELS

NWS determines performance levels largely on an output basis, focusing on the four basic forecasting subfunctions identified earlier. A key performance measure is accuracy, and NWS's national verification program determines accuracy measures for public weather and aviation forecasts for the NMC, the WSFOs and the WSOs. Within the latter two organizations, accuracy is also determined on an individual basis. Similar verification programs are maintained for the NHC, NSSFC, and the RFCs.

The primary purpose of NWS's verification program is to compare performance of these offices both over time and one against the other. The program compares accuracy both in absolute terms and against the historical averages (climatology). Another purpose of the program is to determine the extent to which WSFOs improve on NMC forecasts and similarly the extent to which the the WSOs improve on the WSFO forecasts.

Environmental Data and Information Service (EDIS)

Unless otherwise noted, EDIS authority for its activities is contained in 15 USC 313, 49 USC 1463, and Department of Commerce Executive Order 25-5B. EDIS disseminates global meteorological and climatological data and information to meet the needs of retrospective users in commerce, industry, agriculture, the scientific and engineering community, the general public, and Federal, State, and local governments. It also provides experiment design, data management, and analysis support to national and international meteorological research programs. In addition, it assesses the impact of climatic fluctuations on yield of selected grain crops, energy demand and conservation, and other environmentally sensitive activities.

The EDIS National Climatic Center (NCC) is the custodian of U.S. weather records and the largest climatic data center in the world. It also disseminates environmental satellite data. In addition, NCC houses World Data Center-A, Meteorology and Nuclear Radiation. NCC receives and

processes millions of meteorological observations annually and makes data and related products available to a large and diverse user community. Data are gathered from the National Weather Service, the National Environmental Satellite Service, military services, and international sources to provide a National Climatic Data Base for multiple uses. More than 80,000 subscribers regularly receive published data.

NCC is working with other EDIS and NOAA components and the U.S. Department of Energy to rehabilitate available solar radiation data and combine them with other meteorological data in a form most useful for solar energy applications. NCC now can provide hourly solar radiation data or estimates for 241 locations in the United States. These data are used to determine the availability of solar energy for heating, cooling, and power generation systems. The Department of Energy is using the rehabilitated solar data to develop typical solar radiation values for selected U.S. cities.

About one-third of all the energy consumed in the United States is used to heat, cool, and operate homes, apartments, offices, and other buildings. It has been estimated that building-associated energy consumption could be cut by up to 40 percent if buildings were designed, sited, and built by applying climatic data to minimize undesirable environmental effects and to maximize the impact of beneficial environmental elements. NCC and the American Institute of Architects Research Corporation are cooperating in a pilot project to define the influence of climate on design criteria for residential housing. The goal is to provide specific guidance to engineers and architects so that homes can be designed to be responsive to the climate and thus reduce fuel consumption.

The EDIS Environmental Science Information Center disseminates meteorological scientific and technical literature and information. In addition, it provides computer searches of reference files such as Meteorological and Geoastrophysical Abstracts (MGA). MGA is an EDIS-supported publication of the American Meteorological Society and is an index to the most important meteorological research reported in foreign and English literature.

A comprehensive national collection of meteorological publications is held in the central NOAA Library and Information Services system. It encompasses material inherited from the former Atmospheric Sciences Library, previously the U.S. Weather Bureau Library.

The EDIS Center for Environmental Assessment Services (CEAS) provides assistance to managers of critical national resources by assessing the impacts of climatic variations on food and energy resources, and of offshore energy developments on marine environments and resources.

CEAS prepares data-based studies and weekly assessments of potential effects of climatic fluctuations on national and global grain yields. These reports are used by the Departments of Agriculture, State, and other Federal agencies, as well as by foreign governments and international organizations, to minimize the effects of grain production failures in any region of the world. In addition, EDIS/NOAA, the National Aeronautics and Space Administration, and the Department of Agriculture cooperate in the Large Area Crop Inventory Experiment (LACIE) follow-on program that uses satellite crop monitoring, meteorological observations, and EDIS data-based computer models to make estimates of future crop production.

During the heating season, CEAS issues projections of residential and commercial natural gas demand for multi-State regions of the conterminous United States on a monthly and seasonal basis. The projections are based on an EDIS index of cold weather and on National Weather Service seasonal and monthly outlooks. They are provided to the U.S. Department of Energy and others responsible for energy use and planning. A similar service is being developed for the summer cooling season.

Climatic anomalies, such as the two recent severe winters in the eastern United States, have heavy impacts on agriculture, energy consumption, and the national economy. To realize the enormous potential benefits of predicting such anomalies, it is necessary to develop the capability to model and predict the general circulation of both atmosphere and oceans, as well as the exchange of energy, momentum, moisture, carbon dioxide, and other substances between them. A series of multination major field experiments has been sponsored by international scientific bodies to collect the interdisciplinary environmental data needed for this effort. Under broad names, such as the Global Atmospheric Research Program (GARP), these programs have used sophisticated sensors mounted on extensive arrays of moored and drifting buoys, ships, airplanes, balloons, and satellites, sampling at high rates under careful control. CEAS has played a key role in GARP experiments, providing experiment design, data analysis, and data management support to project managers, and producing merged, validated multidisciplinary data sets for international and national dissemination and study.

EDIS is supporting State-funded State climatologists. As of October 1978, there were working agreements with 41 States and negotiations were underway with the remaining States. The activity is designed to expand NOAA's climatic data/information service capability to users at the local level; it provides a base from which to implement the intergovernmental climate program mandated by PL 95-367, Sec 6.

The EDIS Reference Climatological Station Program involves a network of 21 climatological stations serving as anchor points to stabilize the national network of principal and ordinary climatological

stations. The principal and ordinary climatological stations suffer from changes in location, environment (natural and artifical), and exposure. Thus, continuity is interrupted, and climatic changes can be estimated only by statistical techniques. These anchor stations provide a "baseline" of climatological records, based on many years of observations in an undisturbed environment. EDIS furnishes technical leadership, monitors, and funds the program. The National Weather Service operates the stations and furnishes inspection and maintenance service.

Under Code 10 USC 7393 and Executive Order, EDIS furnishes meteorological data and analyses to be included in the Defense Mapping Agency Hydrographic Center's Pilot Charts and Sailing Directions Planning Guides. In addition, EDIS' National Oceanographic Data Center publishes the Mariners Weather Log, which contains articles on meteorology and is the official record of weather and tropical cyclones over the world's oceans.

National Environmental Satellite Service (NESS)

Public Law 87-332 of September 30, 1961, provided the first appropriation for a National Operational Meteorological Satellite System. This basic meteorological service observing program consists of polar-orbiting and geostationary satellites. The U.S. Department of Commerce, through NESS, is the agency responsible for a national operational environmental satellite system. The Department is charged with operating and improving the system to meet the common requirements of all Federal agencies. The objectives of the operational system are:

- o Provide global imagery of the Earth and its environment on a regular basis, day and night, including direct readout to local ground stations within radio range of the satellite.
- o Obtain quantitative environmental data on a global basis, such as temperature, moisture, winds, radiation flux, and solar energetic particle flux, for use in numerical analysis and prediction programs.
- o Obtain near-continuous observations of the Earth and its environment, collect data from remote observing platforms (including automatic weather stations, balloons, aircraft, ships, buoys, and river and tidal stations), and broadcast weather data to remote locations.
- o Improve monitoring and prediction of the atmospheric, oceanic, and space environments by developing applications of satellite information.

The operational satellite programs are directed toward satisfying the above objectives. The system also includes command and data acquisition stations; a satellite operations control center through which the satellites are controlled and data acquired; facilities for processing and analyzing satellite data and preparing products for distribution to the users; laboratories for developing new and improving existing applications of satellite data and conducting satellite

instrument experiments; and programs for determining requirements of future operational satellite systems.

Satellite Field Services Stations (SFSS) have been established to analyze, interpret, and distribute processed geostationary satellite products to regional National Weather Service offices and other Federal agencies. The products also are made available to private activities at their expense. SFSSs are located in Washington, D.C., Miami Fla., Kansas City, Mo., Honolulu, Hawaii, San Francisco, Calif., and Anchorage, Alaska. The Anchorage SFSS distributes data from both the polar-orbiting and geostationary sytems. The San Franciso SFSS also has the capability of receiving data from the polar-orbiting satellites.

The TIROS N series of environmental polar-orbiting satellites is the replacement for the second-generation ITOS system. TIROS N, the NASA prototype, was launched by an Atlas launch vehicle on October 13, 1978. NOAA A, the first NOAA-funded operational satellite of this series, is scheduled for launch in early 1979. NOAA-funded satellites retain the NOAA name and are numbered consecutively beginning with the number immediately following that last used in the ITOS series. Thus NOAA A will become NOAA 6 after it successfully achieves orbit. The third-generation TIROS N series system is expected to be fully operational by May 1979. However, the two-spacecraft TIROS N system will overlap the current ITOS system for a short time to assure uninterrupted services. These satellites will focus on increasing the accuracy of weather forecasting by providing quantitative data required for improved numerical models. They will carry advanced instruments to provide improved temperature soundings, and microwave channels to facilitate sounding retrieval in cloudy areas. They also will provide advanced multichannel images and will carry a new data collection and platform location system. During the lifetime of the TIROS N series, new instruments may be added or substituted for others. Therefore, the spacecraft are designed for a 25 percent growth capability in terms of weight volume, power, command, and telemetry.

These spacecraft are five-sided boxlike structures that are 3.71 m long, 1.88 m in diameter, and weigh 1,409 kg including expendables. This third-generation system will consist of two satellites in orbit; therefore, there will not be instrumental redundancy on either spacecraft. TIROS N was launched into a near-polar, Sun-synchronous 833-km orbit crossing the Equator in a northward direction at 1530 local time. NOAA A will orbit at 870 km crossing the Equator in a southward direction at 0730 local time. This compares with an average orbital altitude of 1,500 km for the ITOS satellites. NOAA A will be flown at a somewhat higher altitude to avoid extended periods of readout conflict. The orbital period of the satellites will be 101.58 minutes, which will produce 14.2 orbits per day. Determination of orbital parameters will require more sophisticated prediction techniques because gravitational forces become much more significant at these altitudes. Additionally,

maximum solar activity in 1980 will introduce significant perturbations to the orbit.

The TIROS N series satellites carry four primary instrument systems. The Advanced Very High Resolution Radiometer (AVHRR) will provide data for real-time transmission to both Automatic Picture Transmission (APT) and High Resolution Picture Transmission (HRPT) users and for storage on the spacecraft tape recorders for later playback. Thus, the AVHRR instrument will continue and improve upon the ITOS satellite services in stored and direct readout of radiometric data for day and night cloud, sea-surface temperature, and snow mapping. The data from the AVHRR instrument will be available from the satellite in four operational modes:

o Direct readout to ground stations of the APT class, worldwide, at 4-km resolution, of the visible and infrared data. Panoramic distortion will be removed.

o Direct readout to ground stations of the HRPT class, worldwide, at 1.1-km resolution, of all spectral channels.

o Global onboard recording of 4-km resolution data from all spectral channels. Global Area Coverge for commanded readout for processing in the NOAA central computer facility at Suitland, Md.

o Onboard recording of data from selected portions of each orbit at 1.1-km resolution of all spectral channels with Local Area Coverage for central processing.

The TIROS Operational Vertical Sounder (TOVS) system combines data from several complementary sounding instruments on the spacecraft. These instruments are the High Resolution Infrared Sounder (HIRS 2), the Stratospheric Sounding Unit (SSU), and the Microwave Sounding Unit (MSU). The primary instrument providing tropospheric data, HIRS 2, is sensitive to energy from the visible to the carbon dioxide region of the infrared spectrum. This instrument is designed to provide data that will permit calculation of temperature profiles from the surface to 10 mb, water vapor content at three levels of the atmosphere, and total ozone content. The SSU instrument, which is sensitive to energy in the carbon dioxide portion of the infrared spectrum will provide temperature information from the stratosphere. This instrument is being provided by the Meteorological Office of the United Kingdom. The third instrument, the MSU, is sensitive to energy in the oxygen region of the microwave spectrum and will be used in conjunction with the two IR instruments.

The microwave data will permit computations to be made in the presence of clouds.

The Data Collection System (DCS) is being provided by the Centre National d'Etudes Spatiales of France. The French call this the ARGOS Data Collection and Platform Location System. The ARGOS DCS will provide a means to locate and collect data from fixed and moving platforms. It will provide two new services not currently present in the geostationary satellite data collection system. First, it will have the capability to determine platform location, using an inverse Doppler technique. Second, it will be able to acquire data from any place in the world, but most particularly in the polar regions, beyond transmission range of the geostationary satellites.

The Space Environment Monitor (SEM) will measure solar proton flux, alpha particle and electron flux density, energy spectrum and total particulate energy distribution, at spacecraft altitude. The three detectors included within this instrument are the Total Energy Detector, Medium Energy Proton and Electron Detector, and High Energy Proton and Alpha Detector. This instrument will augment the measurements currently being made by NOAA's geostationary satellites. The data from the SEM will be processed at Suitland, Md. and transmitted over a dedicated data link to NOAA's Space Environment Laboratory at Boulder, Colo. within 1 hour of the spacecraft readout. The TIROS N data along with the geostationary data will be used to monitor the state of solar activity, which has a significant effect on terrestrial communications, electrical power distribution, and high-altitude flight in aircraft such as the Concorde SST.

Because of the large volumes of data to be generated by the TIROS N series satellites, and the change to a completely digital data system, a new ground system was required. The ground system consists of two major subsystems, the Data Acquisition and Control Sybsystem (DACS) and the Data Processing and Services Subsystem (DPSS). The DACS includes components at the Wallops, Va. and Gilmore Creek, Alaska Command and Data Acquisition (CDA) stations, the Satellite Operations Control Center (SOCC) in Suitland, Maryland, the Western European Station in Lannion, France, and the Satellite Field Services Station in San Francisco, Calif. All the DPSS components are in the NOAA facility at Suitland.

DACS includes all components necessary to command and control the spacecraft, monitor its health via housekeeping telemetry, and retrieve and transmit the spacecraft environmental data to the DPSS processing and data handling facility. The delivery of TIROS N data from the CDAs to Suitland is accomplished using the RCA American Communications, Inc., commercial satellite communictions network. This system, which includes recently installed Earth Stations at Suitland and Wallops, will deliver the data to SOCC. The data are immediately passed on to the DPSS subsystem for initial processing.

During three sequential orbits, and occasionally four on some days, the spacecraft is out of range of both NOAA CDA stations. To eliminate the resultant time delay in the receipt of the high-priority sounding data during the "blind" period, a Western European readout station was established at Lannion, France. This station will acquire stored sounding data and transmit it to the United States via the eastern GOES satellite located at 75 W.

The DPSS ingests the raw satellite data, and preprocesses and stores them along with appended auxiliary information such as Earth location and quality control parameters. DPSS consists of several unique segments of high-speed computers, intermediate disk storage units, and a mass data storage system. Thus, all the data obtained from a single TIROS N spacecraft for a 24-hour period can be stored on a single tape.

The geostationary satellite program began during the latter half of the 1960s as an operational experiment in which the imaging capability and broadcast system (WEFAX) of the NASA Applications Technology Satellites 1 and 3 were used. The program became an operational reality following the launch of NASA's Synchronous Meteorological Satellites (SMS) 1 and 2 in 1974 and 1975, respectively. NASA released to NESS both SMS 1 and 2 for operational control and use following the initial checkout period. These satellites were the prototypes for NOAA's Geostationary Operational Environmental Satellites (GOES). GOES 1 was launched October 16, 1975, GOES 2 was launched June 16, 1977, and GOES 3 was launched June 16, 1978. The current operational system consists of COES 2 and GOES 3. GOES 2 replaced GOES 1 as the eastern (75 W) operational satellite on August 15, 1977. GOES 1, in turn, replaced SMS 2 as the western (135 W) operational satellite from April 4, 1978 to July 13, 1978, when it was replaced by GOES 3. GOES 1 was moved to 60 E over the Indian Ocean in December 1978 to support the Global Weather Experiment. SMS 1 and SMS 2 remain in orbit in a standby mode. GOES 2 and GOES 3 provide repetitive viewing of the development and movement of destructive weather systems, such as thunderstorms, hurricanes, and major midlatitude storms over much of North and South America and adjacent oceans. The principal instrument is the Visible and Infrared Spin Scan Radiometer (VISSR). The VISSR provides near-continuous cloud viewing with resolutions of 1, 2, 4, and 8 km in the visible wave lengths and 8 km in the infrared wavelength. Full Earth disc pictures are available at 30-minute intervals throughout the day and night; partial disc pictures can be obtained at more frequent intervals to meet special requirements such as viewing development and movement of severe storms. The GOES Data Collection System is used to collect and relay environmental data observed by remotely located sensing platforms, such as automatic weather stations, buoys, and river and tide gages. These satellites also broadcast environmental data to remote locations using the WEFAX system, and collect data for warnings of solar activity, using the Space Environment Monitor. Table 8 shows the planned launch schedule for polar-orbiting and geostationary satellites by the Department of Commerce.

Table 8 - Projected launch schedule
Polar-orbiting system

Satellite designator	Planned launch date	Instruments TIROS N Series
NOAA A	3QFY79	AVHRR - Advanced Very High Resolution Radiometer
NOAA B	FY 1979*	
NOAA C	FY 1980*	TOVS - TIROS Operational Vertical Sounder
NOAA D	FY 1981*	
NOAA E	FY 1982*	SEM - Space Environmental Monitor
NOAA F	FY 1983*	
NOAA G	FY 1984*	DCPLS - Data Collection and Platform Location System (ARGOS)
		HIRS/2 - Modified High Resolution Infrared Sounder

Geostationary system

Satellite designator	Planned launch date	Instruments
GOES D	FY 1980*	SEM - Space Environment Monitor
GOES E	FY 1983*	DCS - Data Collection System
GOES F	FY 1986*	VAS - VISSR Atmospheric Sounder (GOES D and subsequent spacecraft)
		VISSR - Visible and Infrared Spin Scan Radiometer

*Launch Date depends on performance of prior spacecraft.

Research Program for Fiscal 1980

NESS plans an increased effort in technique development to define efficient methods of extracting oceanographic information from satellite data. In another area, calibration procedures will be developed for the visible and infrared channels of the visible and infrared spin scan radiometer, and radiation budget parameters will be obtained from geostationary satellites for the climate program.

Some of the new and ongoing research programs for fiscal 1980 will emphasize the development of global, quantitative products such as sea-surface temperature, sea ice coverage, Earth radiation balance, and cloud cover for inputs to the climate program; development of techniques and instruments for global monitoring of trace gases in the stratosphere; and continued improvement of existing data inputs into the NWS forecast models.

In addition, the operational utility of data obtained from SEASAT 1 will continue to be assessed. Although SEASAT 1 ceased functioning after only 3 1/2 months sufficient data were collected to evaluate its ability to provide information on surface wind stress, boundary layer winds, and major ocean currents. These studies began in fiscal 1979 and will be concluded in fiscal 1980.

Satellite Communications System

The NESS Telecommunications System (SATCOM) is divided into two discrete subsystems, one serving the NOAA polar-orbiting satellites (NOAA) and the second serving the geostationary satellites (GOES) and the associated Satellite Field Services Stations (SFSS). The major elements in the polar-orbiting satellite subsystem are the CDA stations at Wallops, Va. and Gilmore Creek, Alaska, and the Satellite Operations Control Center in Suitland, Md. The Synchronous Satellite Subsystem connects the Wallops CDA station with the Central Data Distribution Facility (CDDF) at Camp Springs, Md.

The CDDF is connected in turn with the Gilmore Creek CDA station, with the five SFSSs located in Washington, D.C., Miami, Kansas City, San Francisco, and Honolulu, and with the NWS San Juan, P.R. WSFO. The Gilmore Creek CDA station relays satellite data by two satellite distribution circuits to the Anchorage SFSS and the NWS WSFOs at Anchorage, Fairbanks, and Juneau.

To support the new TIROS N series operational satellite system, new communication links were added in fiscal 1978. By the end of fiscal 1979, SATCOM will consist of the following high-and medium-speed links:

o 12-megahertz full-duplex terrestrial microwave circuits between the World Weather Building and the Federal Office Building 4 at Suitland for relay of GOES data.

o 2,400-hertz full-duplex circuits from computer output at the CDDF to display units at the SFSSs, the Gilmore Creek CDA station, and the San Juan WSFO.

o 2,400-hertz circuits from the Suitland computer to the Wallops CDA station to transmit WEFAX information.

o 2,400-hertz circuits from the Wallops CDA station to the Suitland computer for relay of GOES Data Collection System (DCS) information.

o 300-, 1,200-, 2,400-, 4,800-, and 9,600-baud circuits for delivery of DCS information from the World Weather Building computer to a multitude of users. Computer-to-computer transmission is used in some cases.

o 7,200-hertz full duplex computer-to-computer circuits for exchange of vertical profile radiometer data between Goddard Space Flight Center and Suitland.

o One 50-line and one 40-line multipoint voice coordination and conferencing network connecting NESS operating facilities.

o Two 100 wpm multipoint teletypewriter circuits connecting various elements of SATCOM.

o A direct alternate voice, data facsimile circuit between Washington and Moscow for exchange of satellite information.

o Two 1.3308 Mbps simplex satellite circuits for relay of TIROS N data from the two CDA stations to Suitland, Md.

o Four alternate 9,600 bps/teletype-voice full duplex satellite and terrestrial circuits between the two CDA stations and Suitland, Md. to relay real-time TIROS N data, to transmit command and control functions to the TIROS N spacecraft, and to provide alternate routing and backup

for TIROS N teletype and voice communications.

o Two full-duplex teletype-voice satellite and terrestrial circuits between the two CDA stations and Suitland, Md. for coordination of TIROS N operations.

o One simplex C-5 conditioned data facsimile circuit between the Wallops CDA station and Suitland, Md. for the relay of sectorized TIROS N HRPT data.

Environmental Research Laboratories (ERL)

ERL R&D programs related to basic meteorologial services are oriented toward providing the understanding and developing the techniques and new technologies that will form the basis for future improvements in the nation's weather services. The responsibility for work on this important function encompasses the mission of several ERL laboratories.

Severe weather is any major natural hazard such as flash floods, severe wind, thunderstorms (including tornadoes and hail), heavy snowstorms, and clear-air turbulence affecting aviation. From the health standpoint, air pollution can be considered a hazard although it results from human activities. The above phenomena are all associated with small- to medium-scale disturbances in the atmosphere.

The National Severe Storms Laboratory (NSSL) in Oklahoma concentrates on severe local storms, especially those phenomena associated with intense thunderstorms. Since 1972, NSSL has used and refined Doppler radar for probing the interior windfields of severe thunderstorms. The early promise of Doppler radar for greatly improved detection and warning of tornadoes led to a cooperative interagency project (Joint Doppler Operational Project with NOAA, DOD, and FAA) to test the operational usefulness of Doppler radar for the Nation's weather services. Results from this Joint Doppler Project have been very encouraging during the 1977-78 storm seasons, and will be used in the design of replacements for the existing NWS radars in the 1980s. Other new remote sensing techniques, some of which can be automated, have been developed by the Wave Propagation Laboratory to assist in the measurement and warning of severe local storm phenomena.

For the spring of 1979, several agencies including the National Science Foundation, National Center for Atmospheric Research, NOAA, NASA, DOD and FAA have jointly organized SESAME '79 (Severe Environmental Storms and Mesoscale Experiment), to be implemented within available resources and built upon specially augmented observational facilities at

NSSL. SESAME '79 will be a more modest attempt at the original SESAME multiscale experiment: its major goals will be to obtain data for regional (fine-mesh) numerical prediction model initialization and verification, and for thorough evaluation of three-dimensional thunderstorm simulation models. Data analysis and model comparisons will be carried out at NSSL and elsewhere into fiscal 1980 and beyond.

Scientists at the Atmospheric Physics and Chemistry Laboratory (APCL) in Colorado have been performing detailed analysis of recent flash flood episodes to discover common features useful for forecasting. They have also pioneered in the development of mesoscale numerical models capable of simulating terrain-induced rain and snowstorms and the growth cycle of heavy thunderstorms. APCL scientists will participate, with NWS, in a four-State Appalachian flash-flood test program beginning in fiscal 1980. They plan to continue diagnostic mesoscale analysis of major flash flood episodes and to continue development of mesoscale numerical models capable of predicting flash floods.

A new radiometer device that shows great promise for warning airline pilots of clear-air turbulence in flight has been developed and tested by APCL scientists on NASA research aircraft during 1977-78. Plans during fiscal 1980 call for operational tests of the radiometer on commercial jet airliners. Another radiometer is being developed to warn pilots of hazardous low-altitude wind shear as they are making final landing approaches to airports.

A major effort will be made during the SESAME '79 experiment to study thunderstorm hazards to aviation. At least 12 research aircraft will be used to collect meteorological data on severe thunderstorms and related features, such as the dry-line and gust-fronts.

A new airborne Doppler radar system has been developed and tested by ERL scientists on one of the new NOAA P-3 aircraft. The airborne Doppler system has potential for measuring detailed vertical velocities, i.e., updrafts and downdrafts, in convective storms overflown by the aircraft. Additional flight tests are planned during fiscal 1979 and after these data are analyzed, specifications for a research prototype airborne Doppler system will be made during fiscal 1980.

Data from the newly instrumented NOAA P-3 aircraft are being analyzed by scientists at the National Hurricane and Experimental Meteorology Laboratory (NHEML) in Florida, to provide new details and insights on hurricane motion and intensification, both difficult to forecast at present with sparse data over the oceans. During fiscal 1980 a new joint initiative with the National Hurricane Center, called Hurricane Strike aims at using the P-3 aircraft and numerical modeling capabilities at NHEML to improve forecasts of short-term intensity and track changes and location of hurricane landfall. In addition, NOAA is seeking additional flight hours for its Research Facilities Center in

fiscal 1980 for increased flight support to improve hurricane modeling especially Hurricane Strike and several other ongoing programs.

Finally, ERL is developing a long-range program in concert with NWS and NESS to optimize new and existing remote sensing technology for an improved regional-scale observing and forecast system (PROFS) during the 1980s.

APPENDIX C - U.S. Department of Defense
U.S. Air Force

The Air Weather Service (AWS) is tasked by Air Force Regulation (AFR) 23-31 to provide environmental services to the United States Air Force and Army. Its primary mission is to support Air Force and Army combat operations in wartime. During peacetime, AWS prepares for its wartime role by providing or arranging daily staff and operational weather support to its military customers. AFR 23-31 also defines certain related environmental and scientific support requirements to other DOD and US Government agencies. Collection, processing, and dissemination of atmospheric and space environmental data, and weather modification are instrinsic to such support.

The Bureau of the Budget Circular A-62, 13 November 1963, divides meteorological services into two types, basic and specialized. Although involved in both services, AWS is more strongly oriented towards the latter.

BASIC METEOROLOGICAL SERVICE

The general functions involved in providing basic meteorological services include observing current weather, communicating weather data and information, preparing analyses and forecasts, issuing and disseminating warnings and forecasts, and archiving weather information for ready retrieval.

The first of these functions, observing, comprises four programs, surface, upper-air, radar, and meteorological satellite. Surface observations are taken by AWS personnel in support of the basic analysis and forecasting function as well as other specialized services. Observations at both Air Force and Army locations (fixed and tactical) are manually obtained; some atmospheric elements being sensed by instruments, some directly by the observer. The observations are made available locally and are collected by the Automated Weather Network (AWN), a high-speed communications network, and transmitted to the Air Force Global Weather Central (AFGWC), as well as to other military and civil locations worldwide. Observations obtained by AWS are used in direct support of military operations, as a basis for preparing atmospheric forecasts, and to fill gaps in the World Meteorological Organization (WMO) network. In fiscal 1979, there are 113 AWS surface observing facilities/locations in the continental United States (CONUS) and 66 overseas.

Upper air observations provide the basic input to the AFGWC numerical analysis and forecasting function. Most of this information is

obtained from U.S. civil and foreign sources as well as 14 rawinsonde (fixed and mobile) and 6 rocketsonde facilities operated by AWS. Additional upper air information over data-void areas is obtained from weather reconnaissance aircraft and in-flight pilot reports from both military and civil aircraft..

The Air Force performs aerial weather reconnaissance in support of U.S. military and civil requirements. Thirteen WC-130 aircraft are provided by the Aerospace Rescue and Recovery Service (ARRS) and seven by the Air Force Reserve (AFRES). Aerial reconnaissance weather officers and dropsonde operators are provided by AWS (for the ARRS aircraft) and the AFRES (for the AFRES aircraft). Weather reconnaissance missions are flown in the Western and Central Pacific in response to military requirements and in the Eastern Pacific, Atlantic, Caribbean, and Gulf of Mexico in accordance with the provisions for the National Hurricane Operations Plan, the National Winter Storms Operations Plan, and various military operations plans.

The weather radar is a prinicpal source of information for making short-term warnings of severe weather. AWS operates 94 weather radar sets (19 overseas). Four of the CONUS-located sets are a part of the U.S. basic weather radar network, and 16 are used in a backup capacity. Thirteen of the AWS weather radars are used to support the National Hurricane Operations Plan.

The final observing program is the meteorological satellite. The Defense Meteorological Statellite Program (DMSP), and operational satellite system managed by the Air Force for DOD, supports military requirements worldwide. DMSP was designed and developed under a total systems concept to provide specialized meteorological data required by DOD. Sensors, communications, and ground processing facilities were developed to provide maximum responsiveness to the military decisionmaker. DMSP provides visual and infrared (IR) images of the entire globe plus temperature and moisture soundings, auroral electron count, and other specialized meteorological data to AFGWC. it also supplies direct, real-time readout of regional cloud-cover information (visual and IR) to selected military locations around the world.

DMSP consists of two polar-orbiting satellites, each in an approximate 830 km polar, Sun-synchronous orbit with a period of 101 minutes. One satellite has an early morning local Equator-crossing time, the other near noon.

The present DMSP spacecraft series (Block 5D) uses an operational linescan system (OLS). The OLS is a digital system designed to format and store visual and IR imagery and data from a number of special sensor systems. The visual sensors detect the brightness of reflected solar illumination from 0.4 to 1.1 micrometers. The IR sensors measure emitted radiation from 8 to 13 micrometers. The visual sensors were selected to

optimize distinction among clouds, ground, and water. Electronic circuitry convert the sensed infrared energy directly into equivalent blackbody temperature, making temperature the displayed parameter. The IR and visual imagery are obtained at near-constant cross-track resolutions of 0.5 km (Fine Data) and 2.8 km (Smooth Data). The Block 5D satellite incorporates selective redundancy and other reliability improvements to achieve longer operational life. It uses both stellar and inertial references, together with on-board processors, to maintain stability and pointing accuracy significantly better than earlier DMSP satellites.

DMSP communications and ground processing systems are designed to produce usable products within 5 minutes after the data stream ends. The central processing facility at AFGWC is linked to the DMSP command readout facilities by a real-time commercial satellite link. High-quality imagery is displayed for manual use and can be input directly into the AFGWC computers. There it is converted into cloud parameters and collated with conventional meteorological data to produce a comprehensive numerical cloud analysis. The Air Force system for direct, local readout is a self-contained unit, including antenna. It is air transportable, making overseas deployment to full-scale operation a matter of hours.

The usefulness of these observations of meteorological elements depends on an effective communications network. The USAF global weather communications system provides for the collection of meteorological data (alphanumeric and pictorial), delivers these data to weather centrals and forecast facilities, and distributes products to the user. Conventional multipoint weather teleype networks, high-speed automated digital facilities, long-haul point-to-point teletype data circuits, facsimile networks, and radio and radio teletype intercept facilities constitute the Air Force Communications Service (AFCS) system.

The Automated Weather Network (AWN) is the backbone of military weather communications, using high-speed computers interconnected with 2400-4800 baud circuitry to deliver foreign and domestic weather data to designated users. Data-intercept sites in strategic overseas areas obtain foreign weather broadcasts for AWN delivery to the AFGWC. Overseas collection and dissemination teletype networks are driven by the AWN Automatic Digital Weather Switch (ADWS) computers. The CONUS ADWS at Carswell AFB, Tex., drives the CONUS Meteorological Data System (COMEDS) and special teletype systems within the CONUS, an integral part of the weather collection and dissemination function. COMEDS serves all DOD activities (AWS, Navy Army, Marines, etc). AWN (including COMEDS) is the prime communications system for the collection and dissemination of military Notice to Airmen (NOTAM) message traffic to all DOD users.

The Weather Facsimile Switching Center (WFSC) at Offutt AFB, Nebr., is the hub of the facsimile system, providing graphic/pictorial data to

worldwide military users. WFSC drives the separate networks serving the CONUS, Europe, and the Pacific, using InterData 50 (ID 50) computers to store and forward required products.

Data requirements of AWS units worldwide are met through a combination of routine data delivery and an Automatic Response to Query (ARQ) system to satisfy its needs for mission-essential, non-routine weather data. In addition to communications responsibilities, AFCS maintains the AWS meteorological equipment. Organizational maintenance is funded through the host base; intermediate maintenance is funded by AFCS. AFCS also operates and maintains the Air Force facilities of the Defense Meteorological Satellite Program.

Basic analyses and forecast requirements for Air Force and Army customers are primarily met by the AFGWC, located at Offutt AFB, Nebr. The AFGWC employs over 700 scientists and technicians (military and civilian) and uses six large UNIVAC computer systems. The computer-based operation of AFGWC uses a build and apply concept. Worldwide weather data are relayed to AFGWC via the high-speed AWN and blended with civil and military meteorological satellite data to construct a real-time, integrated environmental data base. Scientific computer programs further digest the data to construct models of the atmosphere and forecast their future behavior. Final tailoring of the data is accomplished for application to the specific problem of the decisionmaker.

In the Federal Plans for Cooperative Backup Among Operational Processing Centers, AFGWC is designated a backup for the NWS AFOS system, NMC's computational center for commercial aviation wind forecasts, and NWS's facsimile networks. In addition, the National Severe Local Storms Operations Plan designates AFGWC as the backup for the National Severe Storms Forecast Center.

Collecting, summarizing, archiving, and retrieving environmental data are climatologial activities within the Basic Meteorological Service. The USAF Environmental Technical Applications Center (USAFETAC), Scott AFB, Ill., provides environmental data to support the U.S. Air Force, U.S. Army, and other government agency requirements for assessments of natural environmental effects on military plans, weapon systems, facilities, and intelligence activities. USAFETAC collects environmental data from its parent organization (AFGWC), then sorts, checks, and stores these data. USAFETAC operates a facility (Operating Location-A) collocated with the National Climatic Center in Asheville, N.C., for the exchange of climatic data with civil agenices. USAFETAC typically stores worldwide weather observations, surface weather analyses, upper atmosphere analyses, and unique three-dimensional cloud analyses extracted from meteorological satellite imagery. From these stored data, they provide standard climatological products and specialized products such as atmospheric profiles, soil moisture assessments, and probabilities of cloud-free-line-of-sight.

SPECIALIZED SERVICES

Aviation Service

AWS contributes to the specialized global needs of military aviation and makes information available from its facilities to civil aviation. It provides pre-mission briefings and air-ground radio services, tailoring its observations, forecasts, and warnings for unique military aircraft requirements.

General Military Meteorological Service

The Air Force and Army require worldwide meteorological services to support specific operational and planning activities. The General Military Meteorological Service provides these users with support not available from the Basic Meteorological Service or from Specialized Aviation Services.

Military users require meteorological information directed to the needs of weapon systems being developed or used; command and control systems; Army firing units; research, development, and evaluation training and deployment of military forces; and contingency operations.

To provide these special meteorological services, AWS maintains analysis and forecasting facilities in the United States and abroad, including AFGWC and tactical forecast units in Europe and Alaska. Specialized centers, such as USAFETAC and the Joint Typhoon Warning Center at Guam, also fulfill unique military meteorological requirements. Similarly, AWS observation facilities obtain data in direct support of special military operations.

Aerial weather reconnaissance plays a vital role in specific military operations. Essential weather observations from inside/outside tropical cyclones, along tactical deployment routes, in-flight refueling, and missile/satellite recovery areas are obtained by weather reconnaissance aircraft. In addition, these aircraft provide supplemental vertical soundings over data-sparse ocean areas.

AWS, through AFGWC, directly supports DOD Special Strategic Programs, the National Command Authority, the National Military Command System, and the National Security Agency. Tailored environmental support products are disseminated to these customers worldwide.

Centralized facilities, Tactical Forecast Units (TFU), and Weather Teams (WETM) are the basis for AWS support to tactical operations. Centralized facilities include AFGWC, USAFETAC, and AWN. AFGWC and USAFETAC provide direct, mission-tailored and routine support through AWN and tactical communication systems to the TFUs and WETM. TFUs and WETMs

are responsible for refining and updating AFGWC products for tactical operations. WETMs are the basic unit supporting customers in a tactical theater and provide observing and limited forecasting support. Tactical Weather Equipment (TACMET) is being developed to provide weather data to the TFUs and WETMs. The main components of TACMET are: tactical weather system, tactical weather radar (AN/TPS-68), tactical meteorological satellite direct-readout terminal (DMSP Mark IV), and tactical observing kits (TMQ-22 and Belt Weather Kits).

AWS integrates Army weather support into its overall support concept. Specially trained personnel are familiar with Army organizations, concepts of operations, and environmental requirements. AWS support units are aligned and integrated with the Army intelligence organization. Support products are prepared in a manner which is directly usable by Army personnel, integrated into Army intelligence products, and transmitted over existing Army communications systems. In a tactical environment, direct forecast support is normally provided to corps and division headquarters, to armored cavalry regiments, and to separate brigade headquarters. Observer support is normally provided at these levels.

AWS supports US Army and Air Force units assigned for support to the North Atlantic Treaty Organization (NATO). In addition, AWS provides staff and operational support to NATO headquarters that are collocated with AWS units, e.g., Allied Air Forces Central Europe and the Fourth Allied Tactical Air Force at Ramstein, Germany and the Allied Tactical Operations Center at Sembach, Germany. When supporting NATO-earmarked forces and NATO headquarters, AWS complies with NATO Military Committee Meteorological Group policy and procedures. This entails using NATO codes and NATO Unified Met Guidance which will normally be issued by a European national or NATO meteorological centers.

AWS supports unconventional warfare and special operations. Weather support is provided or arranged by the Joint Unconventional Warfare Task Force Staff Weather Officer (SWO). SWOs are also required at the U.S. Army Special Forces Operation Base and the Air Force Special Operations Base. Mission briefing support for aircrews and special forces teams is required at remote forward operating bases called Air Force Special Operations Facilities and Army Forward Operating Bases. AWS personnel will not normally be deployed beyond the bases unless the mission demands direct AWS support (i.e., training indigenous observers, high priority missions, etc). Observing support is required at the locations. At remote forward bases, limited weather observations will be provided by special operations or indigenous support.

AWS staff support consists of SWO and staff meteorologist (Staffmet) functions. The SWO works with the operational customer to determine what support is needed, arranges for that support, identifies problems, and provides mission support. The Staffmet works with the

developing command to document the environmental sensitivities and support requirements of systems under development. HQ AWS System Work Groups bring the SWO and Staffments together to function as analysis and documentation task teams that assist major commands in receiving environmental support for their acquisition programs and deployed systems. SWGs prepare weather support plans that identify AWS resources to meet future weather support strategies.

AWS provides training to AFRES and National Guard Bureau weather personnel to expand the total weather capability during contingencies and national emergencies. National Guard weather personnel are organized into weather flights analogous to active duty weather detachments. These flights are monitored and trained by collocated active duty technical advisers. The reserve mobilization augmentees are trained at active duty weather units and are increasingly being tasked to fill wartime positions.

Other Specialized Meteorological Services

AWS provides meteorological support to the Nation's space and missile programs. This includes a wide range of meteorological observations at the Air Force Eastern Test Range and the Kennedy Space Center. AWS also provides the forecasting services for NASA's unmanned launches at the Kennedy Center.

AWS provides specialized meteorological services for the Space and Missile Test Center at Vandenberg AFB, Calif., and the Pacific Missile Range, which includes Pt. Mugu and San Nicolas Island, Calif., and Barking Sands, Hawaii. AWS also supports the White Sands Missile Range, New Mexico, the Kwajalein Missile Range, and other DOD research and test facilities.

During fiscal 1979, AWS will provide aircraft, personnel, and equipment for dropwindsonde and mobile rawinsonde support to the First GARP (Global Atmospheric Research Program) Global Experiment (FGGE). FGGE is a World Meteorological Organization project whose observational-phase objective is to obtain meteorological and oceanographic techniques for the Northern hemisphere. The AWS reconnaissance effort will supply important wind, temperature, and pressure information for data-sparse areas.

MODERNIZATION PROGRAMS

USAF and Army operational requirements for environmental support are the basis for all AWS actions to improve existing or acquire new capabilities. AWS assesses these requirements and attempts to satisfy them through either hardware acquisitions or technique development.

AWS plans to modernize its base-level weather support systems.

This includes an Automated Weather Distribution System (AWDS) and an Advanced Weather Radar (AWR). Both have been approved by the Air Force, but are not yet funded.

AWDS will contain two major subsystems, an automated observing subsystem and a data-handling subsystem. It will incorporate the latest state-of-the-art data processing, communications, and display technologies. The automated observing subsystem will take, display, and transmit (longline and locally) surface weather observations. The data-handling subsystem will maximize forecaster capability by eliminating most of the labor-intensive tasks associated with forecasting. The modular architectural design permits AWDS to be operated in a fixed or tactical environment and minimizes staffing requirements. Initial installation is planned for late 1983 with completion of overseas and tactical installations by 1988. AWDS will be compatible with the Navy and the National Weather Service systems (NEDS and AFOS).

AWR will be an automated, digitized, S-band Doppler system that will be jointly developed, procured, operated, and maintained by the USAF, NOAA, and FAA within the CONUS. The system will be designed to incorporate the latest technological advances in Doppler radar, data processing, communications, and display modes. The CONUS AWR network will satisfy weather radar requirements in support of the general public, the military, and the entire spectrum of the aviation community. Installation of the AWR is planned between 1983 and 1987.

Fiscal 1980-81 funds have been requested to modify the current AWS AN/FPS-77 weather radars by replacing transmitter and receiver circuitry and antenna components. This action is needed to ensure logistics and maintenance support of this gap-filler radar until AWR is operational.

AWS, through the Air Force Logistics Command, has ongoing programs to upgrade its present weather reconnaissance capability by improving system reliability and maintainability. Long-range plans call for an improved weather reconnaissance and a dropwindsonde capability. These latter two programs have been approved by the Air Force, but lack funding.

The Air Force is modifying airfield meteorological equipment to replace obsolete vacuum tube components with solid-state electronics. These actions will materially reduce logistics and maintenance costs and increase equipment in-commission time.

A $1 million contract was awarded in July 78 for 344 modification kits to convert inventory transmissometers (AN/GMQ-10) to solid-state circuitry.

In the area of atmospheric pressure measurement, USAF has converted from wide-bore, mercurial barometers to dead-weight piston gages used as

regional primary pressure standards. Funds have been requested for fiscal 1979-80 to procure digital display "solid-state" pressure-measuring systems that will replace all base weather station mercurial barometers. This action eliminates the health hazard of mercury and improves accuracy of measurement.

Fiscal 1980-81 funds have been requested to procure new temperature-dewpoint measuring systems to replace the currently installed, obsolete analog electro-mechanical systems. This action will improve reporting accuracy and materially decrease logistics and maintenance costs associated with the current equipment.

Fiscal 1980-81 funds have been requested to procure modification kits to replace 1950 vintage vacuum tube circuitry of the AN/GMQ-13 rotating beam ceilometer with solid state electronic components.

The Air Force (like FAA and NWS) is investigating the possibility of replacing the aging and obsolete airfield wind speed and direction-measuring equipment with modern state-of-the-art systems. Fiscal 1982-83 funds have been requested for this procurement.

Application of the AFGWC data base relies heavily on the interaction between humans and machines to provide accurate and complete service for each operational requirement. A significant improvement to this procedure is the planned acquisition of an interactive processing and display system. It will consist of 35 computer consoles that will be used by highly trained weather technicians to interact directly with AFGWC's computers and thereby eliminate the laborious manipulation of weather maps and displays.

The overall objective of the Air Force meteorological research program is the development of techniques and equipment for observing and predicting meteorological conditions that affect military operations. Requirements for research and technology in meteorology are expressed in Air Force Technology Planning Objectives, Research Objectives, Technology Needs, General Operational Requirements, and Development Goals. In addition, the Air Weather Service provides guidance and direction in the form of geophysical requirements and research objectives. Emphasis is on automated direct and remote sensing systems, weather satellite imagery analysis and application, short-range terminal forecasting and numerical prediction techniques, climatological studies, and cloud and precipitation physics.

In the area of weather radar and remote sensing, the principal effort is on the development of improved instrumentation, preferably automated, for the measurement, processing, display, and analysis of meteorological information. In Fiscal 1980-81, advanced weather radar concepts will be investigated to meet Air Weather Service long-range requirements. Application of FM-CW Doppler radar techniques to detection

and warning of hazardous wind conditions over air bases will be initiated based on the results of experimental studies. A survey of ground-based and aircraft lightning detection and warning systems will have been completed, and the recommendations for equipment development will be implemented. Studies of the feasibility of microwave and electro-optical techniques for indirect sensing of aircraft turbulence, low-level winds, temperature, and humidity will be made.

Radar diagnostic techniques for the operational detection of significant features in storms indicative of their development, motion, and severity will also be developed. In Fiscal 1980-81, conventional radar and Doppler radar data will be analyzed to identify features of hail-producing storms. Coherent optical and microwave radar polarization diversity techniques will be developed for possible use in measuring number concentration, size distribution, phase, and shape characteristics of cloud and precipitation particles that affect aircraft, missile, electro-optical, and communications systems.

Automated ground-based observing and short-range forecasting will continue to be a major effort in fiscal 1980-81 with the continued development of computer-controlled meteorological sensing, processing, and display capability for use at fixed bases and mobile tactical airfields. Automation of 0- to 3-hour forecasts of cloud base height and low-level wind shear will also be a goal. To further improve the quality of short-range forecasts, analysis and use of satellite imagery will be optimized. In fiscal 1980, algorithms will be developed and tested for specifying types of cloudiness and precipitation from satellite imagery. In fiscal 1981, at least one forecasting system based on satellite data will be tested. In a related effort directed toward improving satellite system technology, investigation of infrared and millimeter wave instrumentation and techniques for application to atmospheric sounding, together with theoretical studies of methods for temperature retrieval from IR radiances will be continued.

There is a continuing requirement for specialized climatological information for use in the design or operation of military equipment. In fiscal 1980, models of space and time variations of atmospheric density, temperature, and wind for altitudes up to 90 km, and a Northern Hemisphere atlas of probabilities of precipitation free lines-of-sight will be constructed. In addition, theoretical models will be developed for use in determining the probability of favorable weather in all phases of a military operation. In fiscal 1981, a global climatology of the probability of exceeding specified rainfall rates will be prepared.

Basic research is performed to improve the accuracy and speed of numerical weather prediction. In fiscal 1980-81, fundamental investigations will be carried out on the interaction of mesoscale and synoptic scale circulations, on the effects of computational resolution on accuracy of weather predictions based on mathematical models, and on

optimal computational resolution for prescribed densities and frequencies of observations. Research will also be done on the generalized concept of available thermodynamic energy for a moist atmosphere and on development of a low-order model to investigate the generation of such energy and its conversion into kinetic energy. Finally, a comparison will be made of the accuracy and efficiency of finite-difference and spectral methods in numerical weather prediction models and the effects of sub-grid-scale processes will be incorporated in them through improved selection of parameters.

Research also will be conducted on large-scale cloud systems. In fiscal 1980, instrumented aircraft will be used to extend the data base required for statistical summaries of hydrometeor size spectra, mass spectra, and crystal habit. Two new aircraft instruments designed to obtain water content values in the melting layer will be evaluated. In fiscal 1981, a cirrus particle mass detector will be flight tested. Data from satellites and other platforms will be used to develop methods for remotely sensing hydrometeor size distribution and phase.

In addition to the basic research efforts described above, the Air Force Office of Scientific Research has research programs to take advantage of scientific capabilities within universities and commercial firms. This research is concerned with specifying, modeling, and predicting meteorological factors that may affect Air Force operations. In fiscal 1980-81, investigations in atmospheric electricity, cloud physics, aerosols, and medium-scale meteorological systems will be supported.

U.S. Army

The primary mission of the Army, related to meteorology, is to maximize worldwide combat and strategic effectiveness by continually improving Army-required atmospheric-related products. The Army role is defined in AR 115-10/AFR 105-3, 18 May 1970.

The Army is responsible for much of its own meteorological support. Army artillery ballistic meteorological sections provide upper air soundings in support of artillery firing batteries, battlefield forecasting, and nuclear fallout plotting. Army provides its own weather observations in support of Army weapons systems. A new program mentioned below, initiated in Army units overseas, provides limited weather observations to support the Air Force Air Weather Service forecasters. Air Weather Service provides all forecasts and some observations in support of Army operations.

Army is increasing its own efforts to provide mesoscale weather support to Army operations on the battlefield. Overseas units have

already adopted the new Forward Area Limited Observation Program, through which small belt weather observations kits (adapted from a kit developed by Department of Interior for taking weather observations in support of forest fire fighting) have been issued to Army units. Limited weather observations are being taken by Army personnel, and transmitted to the supporting Air Weather Service forecasters, to improve the quality of weather forecasting on the battlefield. This program is being evaluated for possible Armywide adoption.

Army has adopted the OL-192 Product Improvement Program, which provides a calculator to artillery ballistic meteorological sections. The OL-192, which will be distributed to active Army units beginning mid-1979, will lessen the time required for manual plotting of upper air soundings and provide meteorological data to artillery firing units in a more responsive manner.

Army has terminated two training courses in weather equipment maintenance, and the content of these courses has been integrated into other weather and electronic maintenance courses. This has resulted in a net saving of personnel.

Today Army research emphasis is being placed on atmospheric transmission problems associated with electro-optics and high-energy laser weapons, on artillery and rocket ballistic problems, and on making up-to-the-minute atmospheric information available at the corps or "mesoscale" level. Such information can give the field commander an integrated weather picture.

In the area of electro-optics and millimeter systems, the work will provide data for tri-service programs on atmospheric transmission models and high-energy laser systems development. The models are designed to permit assessment of the anticipated effects of atmospheric conditions, including tactical smoke, on the battlefield performance of electro-optics weapons.

In another tactical area, sensors are being developed for tank and helicopter fire-control systems, artillery fire-and-forget rockets, and improved real-time ceiling and visibility information. It is imperative on the modern battlefield to improve the probabilities of long-range, first-round "hits." Therefore, priority is being given to the development of sensors to measure crosswind effects on projectiles fired from tanks, artillery units, and attack helicopters.

Three types of crosswind sensors are under development. The first is a prototype pulsed laser remote crosswind sensor that can be retrofitted into a tank rangefinder. The second is a passive remote crosswind sensor, miniaturized and suitable for night use. The third type has an integrated, multifunction capability for crosswind measurement, ranging, and imaging and is being jointly developed by the

Atmospheric Sciences, the Combat Surveillance and Target Acquisition (CSTAL) and the Night Vision and Electro-Optics Laboratories.

The helicopter wind sensor is a lightweight, compact, onboard instrument designed to increase the accuracy of attack helicopters firing at short- or long-range targets.

Field artillery units find crosswind effects to be particularly troublesome during the fuel-burning phase of unguided rocket operations. Under evaluation are remote wind sensor prototypes capable of measuring the wind field over the first 500 meters of flight to improve rocket accuracy significantly.

Army personnel, who will use future weapon systems such as COPPERHEAD, have no means for objectively measuring ceiling and visibility data. By early fiscal 1979 a prototype ceiling-visibility sensor, the visioceilometer, will be feasibility tested and demonstrated to the user. This hand held sensor is designed to provide high-resolution ceiling and visibility information in a real-time mode and was based on a ground meteorological direction finder, the AN/GVS-5 laser rangefinder, which was developed by CSTAL.

To help the tactical Army get needed surface data in remote, target and enemy battle areas, the remote automatic weather station has been developed. These low-cost, expendable stations can share a common communications system such as the remotely monitored battlefield sensor system.

One of the major equipment development projects is the field artillery meteorological acquisition system (FAMAS), designed to replace the aging AN/GMD-1 rawinsonde system. FAMAS will use both radio navigation and radio direction finding techniques for wind-finding purposes. FAMAS will be used with Army field artillery units to provide all meteorological data required for ballistic weapons and nuclear fallout predictions. The system will automatically provide data to TACFIRE on a near real-time basis. FAMAS will be easily deployable by either truck or aircraft.

With FAMAS still under development, an improvement to the GMD-1 will be fielded by mid-1979 that incorporates a sophisticated calculator solution for manual computations. The calculator, somewhat like a minicomputer, speeds up plotting procedures used to convert raw meteorological data into ballistic meteorological messages. The calculator will permit reduced personnel, increased firing accuracy, and more frequent observations.

The automatic meteorological system (AMS) will provide commanders with tactical weather intelligence such as a prediction on atmospheric conditions for use of weapon systems at the estimated time of attack.

Additionally, the first-generation AMS will consist of software to provide weather support for smoke, chemical and biological defense, helicopter, and air-assault operations. A software system called AMS-Artillery has been completed for the proposed corps TACFIRE. The software processes all corps artillery meteorological data and produces ballistic corrections for improved first-round hit accuracy.

In addition, meteorological support in the form of atmospheric measurement, prediction and characterization is provided to the Army and Department of Defense elements, as well as to NASA, industrial firms and universities by 14 meteorological teams deployed in the continental United States, Alaska, and the Panama Canal Zone.

Army operations have always been affected by the atmosphere in which they must be accomplished, but never so extensively or critically as today's operations using modern weapon systems. With emphasis on more sophisticated sensors, fire-control systems, and weather intelligence requirements, the $21 million annual research investment by the Army is of increasing importance and will provide the necessary products to cope with fluid battlefields on a worldwide basis. The bulk of the Army's increase in funding for fiscal 1979 is for an engineering development contract for additional models of FAMAS.

U.S. Navy

The Navy "meteorological" program has been, and is, undergoing significant changes. Effective October 1, 1978, the Director, Naval Oceanography and Meteorology (formerly Commander, Naval Weather Service Command) was disestablished, and the Commander, Naval Oceanography Command, reporting directly to the Chief of Naval Operations, was established. Although the new Naval Oceanography Command comprises the elements of the former Naval Weather Service Command, it also includes the Naval Oceanographic Office and major elements of the total Navy oceanographic program. A similar change has taken place in Naval officer personnel where officers formerly designated as meteorological or oceanographic specialists have now been merged into a single, geophysical specialty group. These changes reflect Navy interest in the total maritime environment of the world's oceans in which it must operate. This interest reflects, in turn, the increasing sophistication of the Navy's ships, submarines, and aircraft, their weapon and sensor systems, and command and control systems, all of which are becoming more and more sensitive to the composite air-ocean environment. In short, it is becoming increasingly difficult to separate meteorological and oceanographic products and services being provided to meet fleet requirements in that they are in many cases merged into platform, weapon, or sensor system "forecast effectiveness indices," rather than being provided as a mix of two sets of products and services.

During the recent past, the relocation of the present Commander, Naval Oceanography Command; the Naval Oceanographic Office and the Naval Ocean Research and Development Activity from the Washington, D.C. area to the National Space Technology Laboratories at Bay St. Louis, Miss. has been completed. These collocation and consolidation actions further reflect the multidiscipline, maritime-area-focus approach to Navy environmental support.

Realinement actions concerning the field activities of the Naval Oceanography Command are being developed and will be implemented during 1979. These, also, will reflect the multidiscipline approach, but they are intended primarily to improve the responsiveness and quality of environmental support to the fleets and the fleet commanders in chief.

Technology is being applied as rapidly as possible to improve the effectiveness and efficiency of Naval Oceanography Command operations and, in turn, of the fleet. Some recent developments include the initial operational capability of the Naval Environmental Display Station (NEDS) and of the Satellite Processing Center (SPC). NEDS units are installed and operating at the Fleet Numerical Weather Central, Monterey, Calif; the four Fleet Weather Centrals, at Norfolk, Va.; Rota, Spain; Pearl Harbor, Hawaii; and Guam; the Fleet Weather Facility at Suitland, Md.; and in the National Military Command Center in the Pentagon. NEDS is a "smart" terminal and display device which significantly improves environmental support operations. When fully operational during 1979, NEDS will permit removal of all computers, which have become obsolete and expensive to maintain, from the Fleet Weather Centrals and Fleet Weather Facility. Development of the NEDS devices by the Naval Oceanography Command has included provision for compatibility with the Air Force, Air Weather Service's automated COMEDS, and efforts are underway to provide for compatibility with the NWS AFOS system. This will facilitate the existing exchange of data, products, and services. It is planned that all Naval Oceanography Command activities and detachments, Navy ships with embarked environmental units, and major command and control centers will be provided a NEDS capability over the next several years. The Satellite Processing Center (SPC) is a computerized facility within the Fleet Numerical Weather Central at Monterey, Calif., designed to process data from the Department of Defense and selected national environmental satellite systems to meet specific Navy requirements. An initial operational capability has been achieved, including the processing of data from the recent NASA research oceanographic satellite (SEASAT-A). The Fleet Numerical Weather Central was designated the primary processing center for SEASAT-A data and for the distribution of the processed data to other Federal agencies, selected commercial interests, and the academic community in a proof-of-concept project managed by NASA. This project is now inactive due to failure of the SEASAT-A satellite.

Current plans call for the upgrading of the primary computer system at the Fleet Numerical Weather Central in the fiscal 1980-81 time-frame.

This will provide a significant improvement in global air-ocean processing capability and the capability to generate the increased number of sophisticated weapon and sensor system support products required in support of Naval operations.

The authority for the Naval Oceanography Command program is contained in U.S. Navy Regulations, 1973 (as amended), Articles 0315 and 0316, issued under the provisions of Title 10, U.S. Code, Section 6011, and signed by the President; and subsequent implementing and tasking directives of the Secretary of the Navy and the Chief of Naval Operations.

In response to increased sophistication of weapons systems and requirements for the rapid assessment, evaluation and prediction of the operating environment, the Navy is involved in a broadly based meteorological research program. The guidance and requirements used to formulate the program designed to meet these fleet environmental support needs are derived from a variety of sources. Some of the most important are:

a. Scientific and technical objectives

b. Technical strategy papers

c. Operational requirements

d. Naval Oceanographic mid-range plans

e. Naval Weather Service mid-range plans

f. Naval oceanographic and meteorological support system environmental satellite plan

g. Chief of Naval Operations (CNO)

h. Fleet Commander via the CNO

i. Workshops and studies

j. Interactions between Naval Oceanographic Command, CNO, fleet operations, Naval Systems Command, and R&D personnel

k. Technical advising groups

Major thrusts of the research program are an Automated Environmental Prediction System and a full range of support for remote sensing. Additional efforts cover analysis and prediction, instruments and meteorological measuring systems, and a prediction system for effects on weapons.

Automated Environmental Prediction System (AEPS)

Navy is developing an automated system to provide essential environmental data to Navy Command and Control and other users. The system will (1) automatically process and analyze all available data which defines the global air-ocean environment, (2) predict meteorological and oceanographic conditions with an accuracy commensurate with Navy system requirements, and, (3) tailor product sets for transmission to fleet users via NEDS. The development is modular so that no interruption of current system operation will be necessary. Although the models will be interrelated in order to take into account the physical interactions of the ocean/atmosphere, they will be so designed that any one can be modified or replaced without requiring changes in others. The system will provide coordination and management of communication functions within the total spectrum of data perception, processing, storage and distribution, thereby upgrading the quality and timeliness of meteorological/oceanographic support to the operating forces in a format specifically designed for each type user. AEPS improvements include continued development of the next generation of global and tropical prediction models along with statistical techniques for local area forecasts and improved techniques for ocean analysis and prediction. Another effort during fiscal 1979-80 is the development and implementation of an Optimum Path Aircraft Routing System to provide flight planning data for military aircraft missions. Emphasis in fiscal 1980 development is directed towards (1) system control and monitor and (2) preparation, transmission, and display functions of the automated system.

In order to predict performance of sensor and weapon systems as they are affected by the natural environment the Navy is developing systems which will provide Command and Control with information to determine the most effective sensor/weapon combination, deployment and decision criteria. The prototype software for these systems has been completed and five interim units are to be deployed.

Remote sensors employed by ship, air and space platforms will enable measurement of the environment over a large volume in essentially real time. Efforts under this program include multifrequency radiometer flights to validate sea surface temperature, wind, and ice measurements. Additional flights will be made in support of a spaceborne oceanographic sensor system. A lidar has been fabricated in support of atmospheric and subsurface temperature measurements. Effort will begin to establish the feasibility of a laser making day and night multiparameter measurements. Alternate approaches for the airborne measurements of bathymetry and trafficability in response to amphibious assault requirements are under investigation. A detailed engineering design for the most cost effective passive microwave sensor advanced development model for the Remote Ocean Surface Measuring System will be initiated.

Navy is integrating a Satellite Data Processing Center (SPC) into the Fleet Numerical Weather Central, Monterey Calif. The requirement is to receive and process data from the Defense Meteorological Satellite Program (DMSP) and selected satellites from the National Satellite System. Currently, software is being developed to process DMSP data.

In an effort to preclude duplication of data processing functions, Navy will receive from the NOAA/NESS and Air Force processing centers those data that meet its requirements. Global maritime data requirements not otherwise available will be processed at the Fleet Numerical Weather Central.

Currently, all processing center equipment is installed and is undergoing final acceptance tests. Software for initial operations has been developed and is being implemented. Application models for DMSP data are awaiting implementation.

Fiscal 1980 effort is being applied to additional application models, systems software to process updated sensors, quality control, and display and dissemination procedures to fleet users.

Under an engineering development program, the Navy modifies and improves existing subsystems for receiving and processing future environmental satellite data, for measuring meteorological parameters including those utilizing electromagnetic/electro-optic principles, and for the acquisition and display of environmental subsystems to Naval operational use.

Work was started in fiscal 1978 to modify the exisiting An/SMQ-6, Navy operational environmental satellite acquisition and display system to receive newly available, very high resolution data from DMSP. These data will provide an order of magnitude increase in resolution capability over current APT pictures and improve location and definition of environmental phenomena for which Navy forecasts are required. Severe space constraints aboard ship do not allow an increase in equipment size; therefore, a modification of the current AN/SMQ-6 is the most practical and cost effective method of accomplishing the required improvement.

The AN/FPS-106 weather radar, currently in the Navy inventory, is being modified and redesigned to improve the maintenance profile and increase reliability. In fiscal 1979 a new pulse forming network will be redesigned and tested, taking advantage of new technology to improve the system sensitivity. In fiscal 1980 improvements in the AN/FPS-106 will continue with redesign of the antenna drive mechanism and the magnetron mounting assembly, and design of new high-voltage power supplies and a new receiver. Modern solid-state technology will significantly improve reception and simplify logistics support. The AN/FPS-106 weather radar provides a valuable weather observation data source for improved safety of flight operations at Naval and Marine Air Stations worldwide.

The Navy is continually developing new and better techniques for analysis and prediction of atmospheric parameters to improve forecasting skill for longer periods of time in support of Naval operations.

A "noise-freezing" data assimilation system will be incorporated within the Navy Global Prediction Model and evaluated. Data from the First GARP Global Experiment (FGGE) will be used to test global models. Spectral and finite difference models will be tested to determine superiority for short- and medium-range forecasts. Additional model studies will include stratosphere-troposphere interaction, improved numerical/mathematical techniques, tropical cyclone nesting and test of tropical cyclone parameterization schemes for boundary layer processes. Stretched grid and turbulent transfer work are to be completed for implementation in the 3-D mesoscale model. Satellite techniques will be developed for marine fogs and for forecasting of tropical cyclone strike and intensity. Accurate wind level assignment and incorporation of microwave channel information will be used in conjunction with satellite data retrieval. A satellite Navy Tactical Applications Guide for satellite platforms devoted to forecast applications will be initiated.

Instrumentation programs include a retrofit of the dropsonde to include the recently developed sonde continuous analogue pressure sensor in support of test and evaluation and approval for service use. A cost effectiveness analysis of the dropsonde/AXBT combination is to be completed. A humidity sensor for the dropsonde is also to be developed. Test and evaluation of the mini-refractosonde will be performed and approval for service use will be obtained. Development of the Naval Environmental Display Station (NEDS)-2 prototype will be initiated while phased development of NEDS operating system software will continue. An investigation of the application of a real-time knowledge of atmospheric refraction, wind, etc. in support of instrumentation missions is to be initiated.

APPENDIX D - U.S. Department of Energy (DOE)

DOE supports meteorological services activities at nine of the national laboratories and the Nevada test site. These include Argonne National Laboratory, Argonne, Ill.; Brookhaven National Laboratory, Long Island, N.Y.; Oak Ridge National Laboratory Tenn.; Pacific Northwest Laboratory, Richland, Wash.; Lawrence Livermore Laboratories, Livermore, Calif.; Los Alamos Scientific Laboratory, Los Alamos, N. Mex.; Savannah River Laboratory, Aitken, S.C.; Sandia Laboratories, Albuquerque, N. Mex.; and Idaho National Engineering Laboratory, Idaho Falls, Idaho.

Services include climatic summaries, general daily weather forecasts, and items specifically in support of laboratory operations such as environmental monitoring, atmospheric science research, and hazardous material release assessments. The weather service nuclear support office at the nuclear test site provides continuing meteorological services required by the safety and technical programs associated with all forms of nuclear and nonnuclear experiments by DOE at the site and other places.

DOE's supporting research in meteorology is responsive to the need to evaluate the various safety aspects of transport and storage of nuclear power systems used on space missions, and to provide radiation exposure/dose prediction capabilities in support of nuclear test activities.

Studies performed under the space nuclear power project involve the transport of materials released as a point source. These include particulates released on the ground, as a vapor cloud in a launchpad abort environment, and in the upper atmosphere during reentry abort conditions.

Studies in support of nuclear tests are made to improve the equipment and procedures for measuring, analyzing, and predicting the atmospheric processes involved in the transport of any radioactive effluents from nuclear tests. Plutonium and other radionuclide contamination in the environs are studied with special emphasis on the resuspension and transport of radioactive material by the wind.

This supporting research function also requires continuing development and implementation of radiological prediction methodologies unique to varying test configurations, release modes, and radionuclide inventories.

APPENDIX E - U.S. Department of Transportation

U.S. Coast Guard

14 USC 147 authorizes the Coast Guard to cooperate with NOAA in the observation and dissemination of weather information.

To assist NWS in carrying out its responsibilities, the Coast Guard supplies data from synoptic and other regularly scheduled observations taken on cutters and shore installations. Raw weather observations are transmitted via Coast Guard communications facilities to NWS forecast offices. Coast Guard communications stations also relay meteorological reports from coastal and high-seas shipping to NWS. These data are used by NWS to produce its forecasts, which are then disseminated in part by Coast Guard over Coast Guard radio facilities as Marine Information Broadcasts. Additionally, data-link and logistics support is provided for NWS automated sensors placed at Coast Guard stations and on seven Coast Guard Large Navigational Buoys.

Coast Guard personnel stationed at the NOAA Data Buoy Office (NDBO) in Bay St.Louis, Miss. furnish technical support and liaison for the NOAA Data Buoy Project. Coast Guard vessels are employed to position, deploy, and maintain NDBO environmental buoys, and communications facilities provide data relay functions.

Federal Aviation Administration (FAA)

FAA has completed an Aviation Weather System Preliminary Program Plan which is a guide for developing an Aviation Weather System (AWES) to fulfill FAA's basic weather function. That function is to provide timely, accurate, and operationally meaningful weather information to the National Airspace System (NAS) and its users (civil and military aircraft of all types).

The approach taken in the plan to fulfill the basic function is to define the aviation weather elements, both hazardous weather elements and routine weather elements, to identify the FAA aviation weather requirements connected with the elements, and then to take a system approach to meet the identified requirement.

The hazardous and routine aviation weather elements are listed in the plan to limit the items needed in the system. There are three requirements included in the plan at this time. The FAA hazardous weather requirement is to provide hazardous weather information to the pilot with sufficient warning and accuracy to permit the pilot to avoid the hazard. The FAA routine weather requirement is to provide routine

weather information at any time it is requested by the pilot with sufficient accuracy to permit the pilot to achieve safe and efficient air navigation.

The special weather requirement for general aviation is to provide at airports which have approved instrument approaches, but which presently have no weather observing service, a low-cost means of detecting and transmitting the necessary elements of weather information with sufficient accuracy:

a. To permit the pilot, before and during flight, to ascertain if existing weather is suitable for a planned route to or near one or more of these airports.

b. To permit the pilot, upon arrival at one of these airports, to judge whether or not to execute an instrument approach.

System design requirements will be derived from the mission requirements. They will deal with the technical aspects of the aviation weather system in detecting, processing, disseminating and displaying weather information within the NAS.

One item in the plan which was initiated in the spring of 1978 is the establishment of Center Weather Service Units (CWSUs) in the Air Traffic Control Centers (ARTCCs). Thirteen units were established at that time, with three National Weather Service meteorologists at each center. These three individuals provide weather service to the controllers in the center and to other FAA facilities for two shifts daily. It is planned to expand this service to the other ARTCCs. FAA reimburses the National Weather Service for the salaries of the meteorologists as well as providing end year staffing positions from its resources.

Another item which is underway is the providing of a television display of National Weather Service radars showing detected turbulence in six colors representing six levels of intensity. A contract has been let with fiscal 1979 funds to have one such display for the meteorologist in the CWSU and for the Enroute Flight Advisory Service (EFAS) position in the 44 Flight Service Stations having this special aviation weather service position.

A third item which is underway is a system of providing low level wind shear alerting information at approximately 60 airports. The system uses wind sensors (anemometers) near the approach and departure ends of the runways and compares the readings from these sensors with a centerfield wind sensor. When a wind shear is apparent from this comparison, the tower controller is alerted and the information is passed from the controller to the pilot approaching the airport or preparing for takeoff. The implementation of the 60 systems was initiated with fiscal 1979 funds, and will continue for three years at approximately 20 systems per

year.

A fourth item is a study of the existing aviation weather data exchange between the CWSU, the center controllers, the Flight Service Stations, and the terminal facilities within the center's area of responsibility. The expected outcome of the study is a weather data system requirement to insure proper exchange between the facilities and the service unit. The present communications available is not sufficient to make full use of the capabilities of the CWSUs.

A fifth item which is in the development stage is an automated aviation weather observing and reporting system program. The expected results of this program will fulfill the special general aviation requirement mentioned earlier as well as other requirements to replace the human in obtaining weather observations at some of the FAA airport towers and at the Flight Service Stations. This development program is being pursued in conjunction with the National Weather Service.

The preliminary plan has been reviewed by the user organizations representing general aviation and air carrier interests. Also, the plan has been reviewed by NOAA, DOD, and NASA. As a result of the comments received from these reviews, the plan is being revised to incorporate most of them. The plan will be reissued in final form following its modification.

The FAA's Wind Shear Program has successfully developed airborne solutions to the severe low-level wind shear problem. Airborne testing of wind shear warning avionics will be completed in fiscal 1980 and U.S. air carriers now have several FAA- approved airborne wind shear warning systems which can be purchased for installation in the civil fleet.

Testing of the pulsed Doppler radar prototype for terminal area low-level wind shear detection will be completed in fiscal 1980. Cost-benefit analyses have determined that the above radar system can only be justified at the Nation's busiest airports, and, therefore, only a limited number of these systems may be installed by mid-1980. Forecasting of low-level wind shear associated with fast moving frontal zones and low-level jets is now routine for NWS. Work continues in fiscal 1980 to develop suitable algorithms for forecasting thunderstorm gust fronts through the use of automated analysis procedures.

Modifications in existing Runway Visual Range (RVR) systems, which provide visibility measurements of how far a pilot can be expected to see when his aircraft touches down on the runway. are being investigated to provide measurements of RVR down to 98 meters to support airport operations for properly instrumented aircraft during periods of low visibilities. This will allow aircraft to operate in lower visibilities than at present since the current minimum for operations is 230 meters.

NWS, with funding support from FAA, is continuing development of improved forecasts of thunderstorms for the 0- to 30- minute time period, with 10-minute updates. The analysis of the NWS radar returns is the basis for these improved forecasts which are specifically planned for implementation to meet aviation's needs.

Modifications for improving the detection and display of radar reflectivity levels from storm precipitation that may be hazardous to aircraft will be designed for FAA terminal and long-range ATC radars. The feasibility of using FAA airport surveillance radars for detecting wind shear and turbulence that might endanger aircraft also will be investigated. For these functions the radar will be augmented with pulsed Doppler processing and with a separate steerable pencil-beam antenna. Wind profiles along the runway glide path and turbulence levels associated with rain storms within the 110-km coverage of the radar will be measured.

FAA's System Research and Development Service is analyzing the attenuations to be expected at the two commonly used airborne weather radar spectral bands "C" and "X." National Climatic Center records collected from NWS weather radars are providing reflectivity and geographic extent data for this analysis. Five locations will provide data for the primary thunderstorm areas. As a result of this effort, airlines will have a basis for making a choice between the two wave lengths.

FAA is supporting developments to integrate the helicopter into all-weather operations of the National Airspace System. Efforts are being initiated to obtain information on the icing environment below 3.3 km to provide airworthiness standards that will be the basis for certifying helicopters for all weather operations.

The authority of FAA to perform research and development functions in the aviation weather area is contained in the Federal Aviation Act of 1958.

APPENDIX F - Environmental Protection Agency (EPA)

EPA works with State and local government agencies to ensure adequate air quality meteorolgical support programs. The Clean Air Act Amendments of 1970 incorporate a number of elements that require meteorological competence including sections 103, 110, 303, and 313. The Clean Air Act Amendments of 1977 reinforce the requirement for meteorological competence, particularly sections 121, 126, 127, 128, and 310. Applied research and operational meteorological support to EPA is provided by the Meteorology Laboratory, Air Resources Laboratories, NOAA.

Operational support includes review of the meteorological aspects of environmental impact statements and State Implementation Plans. the application of dispersion models, and the preparation of dispersion studies and evaluations. Applied research support is in the area of model development and evaluation, climatic analyses, and the atmospheric effects of pollutants. Dispersion and transformation simulation models for inert and reactive pollutants are under development and evaluation for several temporal and spatial scales. Planetary boundary layer models to predict the meteorological variables for use with dispersion models are under development. Studies are underway on the prediction of air quality, air quality-visibility relationships, and pollution potential climatology.

APPENDIX G - National Aeronautics and Space Administration (NASA)

The NASA Weather and Climate Program is an integrated effort to develop new technology, hardware, applications, and theory for improving the quality of meteorological information to meet national needs. A central assumption to all of NASA's efforts is that by use of satellite observing systems, much of the needed data can be collected and processed in a more cost effective manner than by any other means. For convenience in management, the NASA program is divided into three components:

- Development of coordinated space and ground systems for severe storm detection, prediction, and warning.
- Development and application of space technology to improve forecasting for periods up to 2 to 3 weeks.
- Investigation of the potential for monitoring and predicting climate changes.

In the study of severe storms, NASA is using space, aircraft, and ground-based technology to obtain an improved understanding of the dynamics of severe storms such as thunderstorms, tornadoes, hurricanes, and typhoons. Development of models and forecast techniques using satellites, aircraft, and other data to improve the prediction of severe storms is underway. This research also will lead to the specification of new space capabilities for severe storm observation, detection, and prediction. The NASA-developed VISSR Atmospheric Sounder (VAS) will be launched in August 1980 on the Geostationary Operational Environmental Satellite (GOES-D) to provide measurements of the vertical structure of temperature and humidity in the vicinity of severe storms. The maximum time resolution for clear sky conditions is sounding over a 750-km-wide swath every 30 minutes with a maximum space resolution of 30 km^2. This will be a big step forward in developing a space capability for the detection and monitoring of these storms.

An Atmospheric Cloud Physics Laboratory (ACPL) will be flown on Spacelab III in April 1981 and twice per year thereafter. ACPL will significantly increase the level of knowledge of cloud microphysical processes. The low-gravity environment in orbit will allow cloud physics experiments to be performed under conditions similar to, and for time periods identical to, those occurring in nature--something that cannot be done on Earth. The experimental results will be used to verify or improve our theories and to improve severe storm models and severe weather prediction techniques.

Selected experiments will capitalize on the geostationary meteorological satellite capabilities for localized, adverse weather conditions. An experiment in improved detection and prediction of frost and freeze conditions in Florida, in cooperation with NOAA, will be

brought to operational capability during fiscal 1980. NOAA will evaluate the results and determine the manner in which operational use will be made of this new capability.

A sophisticated information processing system (AOIPS - Atmospheric and Oceanographic Information Processing System) has been developed by NASA and is in current use for research. This system can process satellite observations (as well as many other types of data) into false color image displays on a video screen. Image color keys, time rate of image progression, horizontal scaling, and so on, can be easily changed with a great deal of flexibility by the investigator. In this way one researcher can discern and study a large number of interesting phenomena over the phenomena lifetimes. Such equipment development also leads the way to development of similar equipment for operational uses - especially for monitoring severe storms development and motion. Such information forms a firm basis for storm warnings.

Specifically intended for improvement of conventional forecasting, is NASA's development of the TIROS-N, a third generation operational meteorological satellite. The first TIROS-N, launched in October 1978, will be followed by other TIROS-N type operational follow on satellites funded by NOAA and designated NOAA-A through G. TIROS-N model satellites will provide global monitoring of weather systems and highly accurate quantitative measurements of the atmospheric state. NASA will also develop advanced instrumentation for improvements of the TIROS-N series of satellites for improved atmospheric soundings, higher spatial and temporal resolution imagery, and observations of the distribution and total content of atmospheric constituents such as ozone. TIROS-N spacecraft will provide direct support to NWS and the international Global Atmospheric Research Program (GARP). NASA will participate in the analysis of GARP-produced data, particularly data acquired from space, and in interpretation and application of those data through the development of advanced techniques for modeling and prediction. Supporting GARP in addition to the TIROS-N type low-altitude, Sun-synchronous satellites, will be five geosynchronous satellites spaced over the Equator, three United States (SMS/GOES), one European (ESA - Meteosat), and one Japanese (GMS). NASA technology has been applied extensively in the development of the U.S. spacecraft. The GARP data-gathering efforts are anticipated to continue for several years with the FGGE (First GARP Global Experiment) data-gathering period beginning in late 1978.

NASA climate research covers the long-term characteristics of the atmosphere-ocean-land system and will emphasize the understanding of the physical basis of climate. NASA efforts will be directed mainly toward climate modeling and the development of a space-observational capability. Space data already gathered can yield information vital to national climate interests when additional analyses and corroborative data are collected. These data include global total ozone measurements from

Nimbus 4, 5, and 6; global precipitation, soil moisture, snow, and ice cover from the microwave sensors of Nimbus 5; and important data on the Earth's radiation budget from Nimbus 6. These climate analyses will incorporate additional data on atmospheric constituents for Nimbus 7 and limited oceanographic data from SEASAT-A.

NASA studies, performed with leading climate scientific investigators and in conjunction with national planning for climate research, have served to identify climate modeling and data requirements that now can be measured on the required global basis by satellite techniques. One of these requirements is a global determination of the components of the Earth's radiation budget. The Earth Radiation Budget Satellite System (ERBSS) will be a three-spacecraft system designed to meet this need. Launching of the three spacecraft is scheduled for 1983.

The authority for NASA activities in meteorology ensues from the DOC-NASA basic agreement (July 1973), and Circular Number A-62 (November 13, 1963) from the Executive Office of the President, Bureau of the Budget.

ACRONYMS

ABDIS	Automated Service B Data Interchange System
ACPL	Atmospheric Cloud Physics Laboratory
ADWS	Automatic Digital Weather Switch
AEPS	Automated Environmental Prediction System
AFB	Air Force Base
AFCS	Air Force Communications Service
AFGL	Air Force Geophysics Laboratory
AFGWC	Air Force Global Weather Central
AFOS	Automation of Field Operations and Services
AFR	Air Force Regulation
AFRES	Air Force Reserve
AHOS	Automated Hydrologic Observing System
ALWOS	Automated Low Cost Weather Observation System
AMS	Automatic Meteorological System
AOIPS	Atmospheric and Oceanographic Information Processing System
APCL	Atmospheric Physics and Chemistry Laboratory
APT	Automatic Picture Transmission
ARQ	Automatic Response to Query
ARRS	Aerospace Rescue and Recovery Service
ARTCC	Air Route Traffic Control Center
AV-AWOS	Aviation Automated Weather Observation System
AVHRR	Advanced Very High Resolution Radiometer
AWDS	Automated Weather Distribution System
AWES	Aviation Weather System
AWN	Automated Weather Network
AWP	Aviation Weather Processor
AWR	Advanced Weather Radar
AWS	Air Weather Service
CAT	Clear Air Turbulence
CDAS	Command and Data Acquisition Station
CDDF	Central Data Distribution Facility
CEAS	Center for Environmental Assessment Services
CNO	Chief of Naval Operations
COMEDS	Continental U.S. Meteorological Data System
CONUS	Continental United States
CSTAL	Combat Surveillance and Target Acquisition Laboratory
CWSU	Center Weather Service Unit
DACS	Data Acquisition and Control Subsystem
DCPLS	Data Collection and Platform Location System
DCS	Data Collection System
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy

DOT	Department of Transportation
DPSS	Data Processing and Services Subsystem
EBS	Emergency Broadcast System
EDIS	Environmental Data and Information Service
EPA	Environmental Protection Agency
ERBSS	Earth Radiation Budget Satellite System
ERL	Environmental Research Laboratories
ESSC	Environmental Studies Service Center
FAA	Federal Aviation Administration
FAMAS	Field Artillery Meteorological Acquisition System
FGGE	First GARP Global Experiment
FNWC	Fleet Numerical Weather Central
FM-CW	Frequency Modulated - Continuous Wave
FSS	Flight Service Station
GARP	Global Atmospheric Research Program
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
HIRS/2	Modified High Resolution Infrared Sounder
HRPT	High Resolution Picture Transmission
IR	Infrared
ITOS	Improved TIROS Operational Satellite
LACIE	Large Area Crop Inventory Experiment
MGA	Meteorological and Geoastrophysical Abstracts
MOS	Model Output Statistics
MSU	Microwave Sounding Unit
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAWAS	National Warning System
NCC	National Climatic Center
NDBO	National Data Buoy Office
NDC	National Distribution Circuit
NEDS	Naval Environmental Display Station
NESS	National Environmental Satellite Service
NHC	National Hurricane Center
NHEML	National Hurricane and Experimental Meteorology Laboratory
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Survey
NSSFC	National Severe Storms Forecast Center
NWP	Numerical Weather Prediction

NWR	NOAA Weather Radio
NWS	National Weather Service
OLS	Operational Linescan Systems
OMB	Office of Management and Budget
PROFS	Prototype Regional Observing and Forecasting Service
R&D	Research and Development
RAWARC	Radar Report and Warning Coordination
RFC	River Forecast Center
RVR	Runway Visual Range
SATCOM	NESS Satellite Communications System
SEASAT	NASA's research satellite dedicated to marine observations
SEL	Space Environment Laboratory
SEM	Space Environment Monitor
SESAME	Severe Environmental Storms and Mesoscale Experiment
SFSS	Satellite Field Services Station
SMS	Synchronous Meteorological Satellite
SOCC	Satellite Operations Control Center
SPC	Satellite Processing Center
SST	Supersonic Transport
SSU	Stratospheric Sounding Unit
SWO	Staff Weather Officer
TACMET	Tactical Weather Equipment
TDL	Techniques Development Laboratory
TFU	Tactical Forecast Unit
TIROS	Television Infrared Observation Satellite
TOVS	TIROS N Operational Vertical Sounder
TWS	Tactical Weather System
USAF	United States Air Force
USAFETAC	USAF Environmental Technical Applications Center
USDA	U.S. Department of Agriculture
VAP	Voluntary Assistance Program
VAS	VISSR Atmospheric Sounder
VHRR	Very High Resolution Radiometer
VISSR	Visible and Infrared Spin Scan Radiometer
VOR	Very High Frequency Omni Range
VRS	Voice Response System
VTPR	Vertical Temperature Profile Radiometer
WEFAX	Weather Facsimile
WETM	Weather Team
WFSC	Weather Facsimile Switching Center
WMO	World Meteorological Organization

WSFO	Weather Service Forecast Office
WSMO	Weather Service Meteorological Observatory
WSO	Weather Service Office

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